73

JANUARY 1968

60¢

AMATEUR RADIO

including the

DIODE CIRCUITS HANDBOOK

January 1968

Vol. XLVII No. 1

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Editor

Published by
Wayne Green, W2NSD/1

Cover by Wayne Pierce K3SUK

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $12.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

de W2NSD

never say die

Miller

My long editorial about Miller in November has brought quite a response. If Miller is not an international scoundrel and pirate, he certainly has gone to fantastic lengths to make it seem he is. I know he has me convinced now.

Hundreds upon hundreds of hams now feel that they have been hoodwinked by a fast-talking con man. They want to know if Don did, as he claimed, collect $12,000 from the DX clubs last summer. They want to know, if this is true, why he is now asking for more donations. His recent letter in October did not answer any of the questions, it just spent itself in a tirade against the ARRL, threatening suit, and requested more and more donations.

Twelve thou is a very big bundle and in the Indian Ocean it will carry you along for a long, long time. That area is famous for low prices. I think we all want to know that Miller isn't salting away the major portion of these donations for his retirement.

A letter from the Seychelles says, "Congratulations on the article 'Miller & Company'. It was about time that something like that appeared. We here knew all about the events which were going on in our area and we struggled to put a stop to it. The results were disheartening at first because although we *knew* about the Laccadives-Chagos hoaxes we could not get the government to take action. The local newspaper started things going and the Development Secretary has announced that Miller has been informed that he is 'personna non grata' here and that he would not at any time be allowed to land in VQ9 or in any of the islands of the British Indian Ocean Territories. His license for VQ9 has expired and will under no circumstances be renewed. The authorities in VQ8 have been alerted and it is possible that his rapid departure from VQ8 may have been the result of Telecommunications being after him to answer some embarrassing questions."

It looks as if less and less of the world is available to Don. With the generous financial aid of the DX'ers, Don has probably done more to hurt amateur radio and its future than any other one ham in history.

Charles Jimenez WA4ZQO
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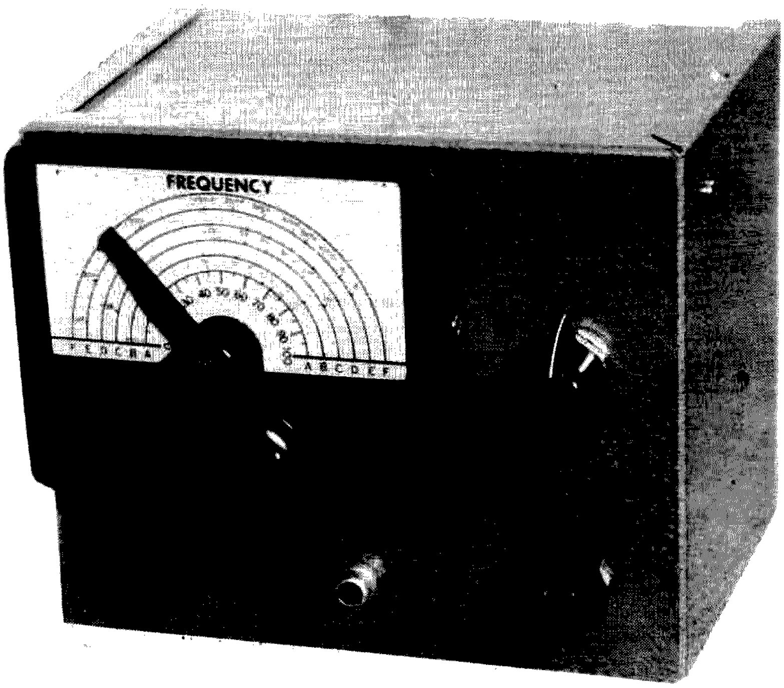
Miami, Florida

IC Square-Wave Generator



The integrated-circuit square-wave generator.

This project was designed primarily for those who wish to acquaint themselves with, and gain experience using, integrated circuits. The square-wave generator described is a rather easy construction project. This is not to say, however, that it sacrifices performance for the sake of simplicity. In fact, several shortcomings of usual square wave generator circuits have been overcome in this design. The construction of this unit will result in a fine piece of test equipment which will be handy around any ham shack.

Circuit details

The circuit which generates the basic square wave form is shown in **Fig. 1.** This is called an astable multivibrator. The gates G_1 and G_2 are from a Fairchild μL 914 integrated circuit. It's a dual two-input gate and should be familiar to many *73* readers.

Each gate is cross-coupled to the other through a resistor-capacitor network which determines the operating frequency. Different capacitors are switched in for changing frequency bands. There are five bands: band A—10 Hz to 150 Hz; band B—100 Hz to 1.5 kHz; band C—1 kHz to 15 kHz; band D—10 kHz to 150 kHz; and band E—70 kHz to 1 MHz. In order to vary the frequency within these bands, normally you have to vary both R_1 and R_2 simultaneously. But by varying only R_1 we can obtain the same bandspread and save the cost of a ganged pot. Unfortunately this will destroy the symmetry or squareness of the output waveform. This can be remedied and, as you will see later, the remedy brings along a couple of extra advantages of its own.

The simple astable multivibrator of **Fig. 1** would work nicely if it were not for one big shortcoming. It may cease oscillating when switching frequency ranges or it may

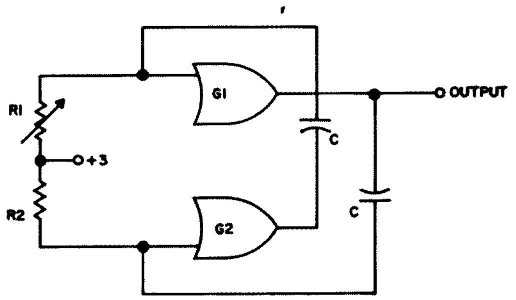


Fig. 1. Simple astable multivibrator circuits.

fail to start up when turned on. This happens when both gates saturate at the same time. In normal operation, G_1 and G_2 conduct on alternate cycles; that is when G1 conducts, G_2 is cut off. This process is insured by the capacitors which drive the gates by charging and discharging alternately.

However, suppose now that you are changing bands. As the arm of the bandswitch moves from one capacitor to the next there will be a time interval where there is no capacitor in the circuit at all. Both gates will now see a positive voltage at their inputs through R_1 and R_2 and will conduct heavily. The multivibrator will now be locked and cannot be started up again unless you first turn off the power. Obviously, it would be very frustrating to have to turn off the power whenever you wanted to change bands. I ought to know since it kept happening to me in my early stages of experimenting.

The seemingly insurmountable problem was easily overcome by using a couple of diodes. **Fig. 2** shows the circuit, known as a self-starting circuit. By referring to **Fig. 1** and **6** you'll be able to see how this circuit works. The two diodes are connected to each output and to the junction marked (X). The +3 V for R_1 and R_2 is now supplied through D_1 and D_2 from the collector of either gate. Remember that when a gate is cut off the collector goes positive and +3 V appears at junction (X). The circuit will operate properly as long as at least one gate is cut off. Now if both gates should happen to saturate at the same time when switching capacitors, the positive voltage at (X) will disappear, tending to cut off the gates immediately. In other words, the diodes, which form the OR gate, will not allow the multivibrator to lock in a saturated condition. Proper operation will begin when the next capacitor is switched in. We now have a reliable astable multivibrator circuit which produces rectangularly shaped waves.

As stated earlier, the method used for varying the frequency destroys the output wave's symmetry. When R_1 is varied, the output may change from a square wave to a rectangular wave or pulse, for instance. Of course, this change in wave shape has no effect upon the frequency as it is varied. In order to correct the wave shape, the output of the multivibrator is fed into a Fairchild μL 923 J-K flip-flop. The action of this flip-flop is shown in **Fig. 3.** The μL 923's output *changes* only when the input signal goes *negative*. Notice that the output is always a perfectly symmetrical square wave, regardless of the shape of the input waveform. The input can be spikes, pulses, rectangular waves or any other waveform which has a fast negative going portion. It can also be seen from the diagram that

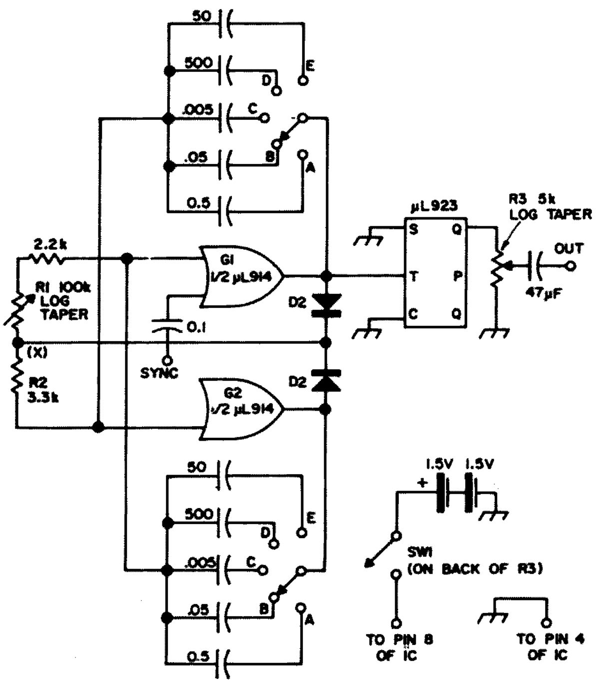


Fig. 2. Complete square wave generator. Bandswitching capacitors are 10% or better tolerance. Resistors are 1/4 watt.

the output frequency is one-half the input frequency. This means that the multivibrator is actually operating at twice the frequency indicated on the front panel dial. The generator puts out a beautiful square wave to 1 MHz and beyond. A slight amount of overshoot on the rising portion of the square wave is normal at high frequencies. The S (set) and C (clear) inputs are both grounded, and the P (preset) input and the $\overline{Q}$ output are disregarded.

Synchronization pulses are fed into gate G_1 for locking the generator's frequency to some external source or oscillator. For in-

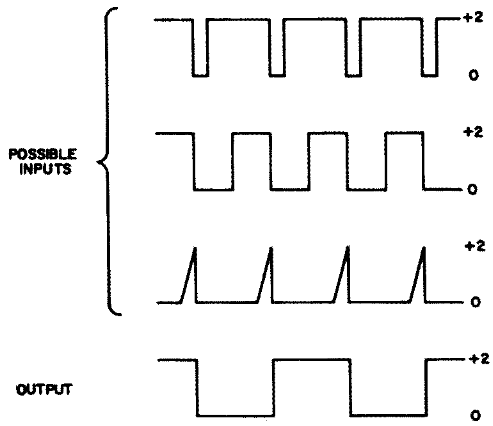


Fig. 3. Operation of the μL 923 flip-flop. Note that regardless of the shaps of the input waveform, the output is always a perfectly symmetrical square wave.

stance, by feeding a 100 kHz signal from your receiver's crystal calibrator, you can lock the generator at 100 kHz, 50 kHz, 33 kHz, 25 kHz, etc. Of course, this will result in excellent frequency stability and accuracy. Be careful not to feed too much signal into the sync terminals, as you might cause erratic operation.

The output level is controlled by a 5-k pot at the output of the flip-flop. The actual value isn't too important as long as it isn't too low. Otherwise you might load the flip-flop too much. Don't go below 1k. The use of a log-taper pot will permit adjustment down into the millivolt region for low-level audio work. The output voltage is about two volts into a high-impedance load.

The supply voltage for the unit is taken from two 1.5 volt D cells in series. Current drain is less than 40 mA. Remember that pin 8 of both IC's is connected to the +3 V and pin 4 of both is connected to ground or minus. A colored line or flat portion on the edge of the IC's body identifies pin 8.

Diodes D_1 and D_2 can be almost any signal diode. Parts values should be followed rather closely to insure adequate band coverage.

Construction

The printed circuit layout is given for those who want to make their own PC boards. You can get an idea of the front panel arrangement from the photo. Actually there is nothing critical about layout or construction so you can arrange things inside to your liking. I used a 4 x 5 x 6 minibox for my unit, which is just right if you use a Millen 10039 vernier dial as I did. This is a compact unit, and using a larger dial will mean using a larger cabinet. The Millen dial is rather expensive and maybe you'll want to use one of the imports and make your own scale. Since I'm on the subject of cost, I might as well say that the whole project will come to about $20.00 with all new parts, including the Millen dial. With an imported dial, you can probably knock $5.00 off that figure.

Calibration

You might have noticed by now that the scale on my dial is not linear. This is because I used a linear taper pot for R_1, since it was available. I'm not particular about such things but if you prefer a more linear scale, I would suggest trying a log- or semi-log taper pot. Keep in mind the fact that most vernier dials turn only 180° as opposed to the normal 270° turn of a pot. You might have to adjust the position of the pot in the dial to insure proper bandspread.

Calibration can be achieved only by the use of a scope or frequency counter. If you don't own one maybe you can gain

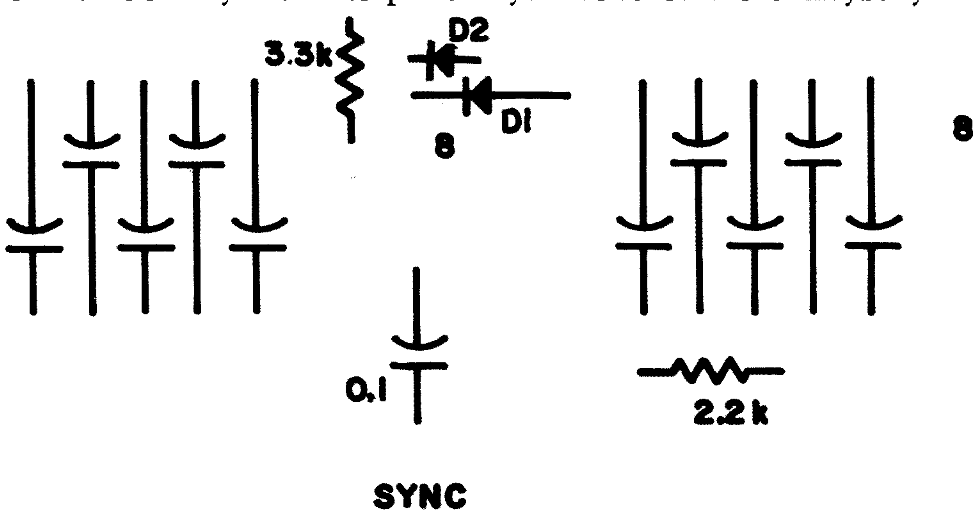


Fig. 4. Full size layout of PC board. This is a bottom view with components mounted on top.

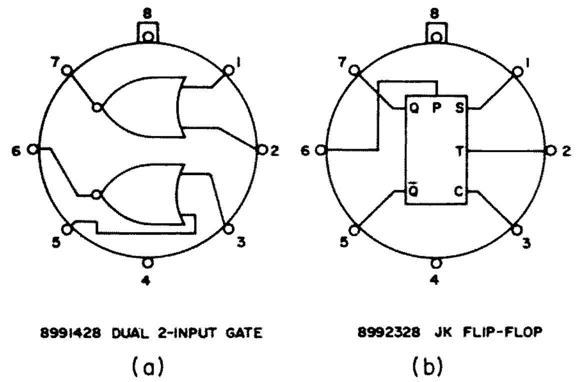


Fig. 5. Basic diagram for the IC's.

access to one for about fifteen minutes or so. By using 10%, or better, tolerance capacitors you'll only have to calibrate the lowest frequency band. On each succeeding band, the frequency is ten times the frequency at the same point on the previous band. The simplest method of calibration is with a 60-Hz sine wave, which can be supplied internally on most scopes.

To calibrate the lowest band (band A) the following procedure can be used. First, allow the scope to warm up for a few minutes until it becomes stable. Turn off the internal sync of the scope. Apply the 60-Hz sine wave to the vertical input of the scope and adjust the sweep frequency until you obtain six full cycles on the screen. Since you are not using the internal sync, you'll have to adjust it very carefully to stabilize the pattern. With six full cycles on the screen, the sweep frequency is now set at 10 Hz. Next, feed the square wave from the generator to the scope and tune the generator's frequency until you obtain one full cycle of a square wave. Be careful not to move the sweep frequency of the scope. The square wave generator is now set at 10 Hz and can be marked on the dial. Tune the generator again until two full cycles are visible on the screen. The scale can now be marked at 20 Hz. This process can be continued on up to 100 Hz. Afterwards, go back and repeat it all over again to make sure you have the proper calibration. Once you have made certain that there are no errors, you can mark the rest of the bands as outlined previously. On band E, you can listen to the signal on a broadcast receiver to see if it checks out. The bands on my unit did not exactly come out in multiples of ten because I used 20% tolerances capacitors from my junk box. Even so, they came out very close.

Operation

Square waves are very handy for testing amplifiers of all sorts in conjunction with an oscilloscope. In audio work they will reveal poor high or low frequency response, ringing and other ailments. Of course, you don't need a scope just for general testing of audio amplifires and such. A simple signal tracer will do.

Speaking of oscilloscopes, you can use 500-kHz square waves for adjusting compensating capacitors in scope probes and step, or decade, attenuators. Usually, the instruction manual of your scope will outline the proper procedure. Since this unit will supply a signal at up to 1 MHz in frequency, it can be used to fix or test amateur or broadcast receivers. However, a detailed discussion of testing with square waves is beyond the scope of this article.

I'm sure that if you build this square wave generator, you'll be very pleased with its performance and reliability.

. . . WA4ZQO

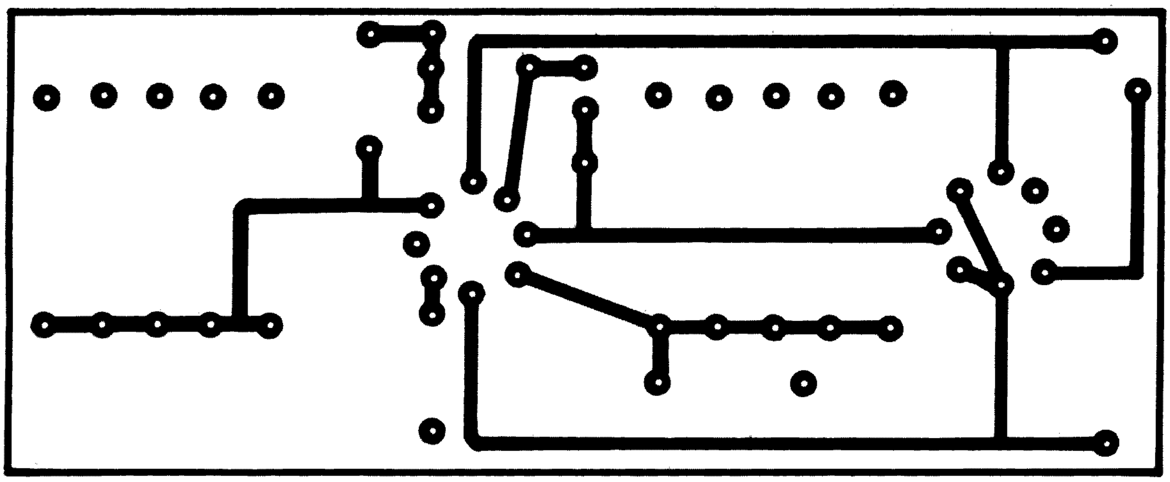


Fig. 5. Full size printed-circuit board used in the IC square-wave generator.

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Tuning in on Bonadio's Satellites

There are billions and billions of minute satellites or micro-meteorites *in-orbit* around the earth. You can tune in to a hundred of them a minute on 13 meters.

Eons ago, according to theory, there was a large planet between Mars and Jupiter. There are now thousands of asteroids in that area. If a planet had been there, it would have been chemically similar to the earth. This would include much sand in crystalline form. If such a planet broke up, there could easily be billions of tons of sand and similar particles scattered in space.

When these wandering crystals intercept the earth's path, they do so at speeds of ten to eighty kilometers per second. Their speed and mass combine to burn them up when they enter the atmosphere.

Burn-outs are nicely explained by the North American authority on meteors, Dr. D. W. R. McKinley, VE3AU, Ottawa, Ontario, Canada. His paperback book, *Meteor Science and Engineering* is published by the McGraw-Hill Book Company.

What happens to the particles which come close to the earth, but miss its atmosphere? For eons many have been captured by the earth's gravity and are orbiting around it.

I first detected these particles about three years ago. My theory was advanced June 4, 1965, in the Watertown (New York) Daily Times, a year before results of later Russian and American space probes were made public. The particles were dubbed "Bonadio's Satellites" by the newspaper's science writer.

My theory was borne out by the Soviet moon probe, *Luna 10,* and the *American Mars* probe, *Mariner IV. Circumlunation* (orbit of the moon) was attained by Luna 10 on April 3, 1966. According to *Scientific American,* "measurements by Luna 10 show that it is being bombarded by micro-meteorites (Bonadio's satellites) at a rate *100* times higher than the rate observed in interplanetary space."

Similar particles were detected in the gravitational field of Mars by Mariner IV. I postulated that these particles around the moon and Mars were the same as those I detected by radio around the earth.

The count

The recent probes to the moon, Mars, and around the earth found many more micrometeorites around the earth, moon and Mars than in space. The ratio is about 100 to 1. Such a ratio is impossible to ignore. Space data tells us nothing more about it.

It seems that space scientists have not yet been able to separate and identify an orbiting grain of sand, at modest speeds, from a *non*-orbiting bit, of less weight and higher speed. So, they report total counts.

I claim to have a means to prove that about 99% of these are in orbit; are real satellites; are countable apart from meteors, and that each has a great similarity to others. You can make your own count.

Piggy-back radar

There are huge signal beams from the Voice of America stations in Ohio and North Carolina. They frequently beam to Europe on 21.485 MHz and 21.650 MHz respectively, in the 13-meter band. The beams are about *ten million* watts E. R. P.

The Ohio beam passes ideally over northwestern New York State, Toronto and Ottawa, Ontario, and Montreal, Quebec. The North Carolina beam passes over Washington, D. C., Delaware, Eastern Pennsylvania, New Jersey, Southern New York State and the New England states.

Other VOA stations would probably do as well for other areas.

When the 15-meter band has not opened for the day, for amateurs, the VOA is often warming up on the air. The signal will be

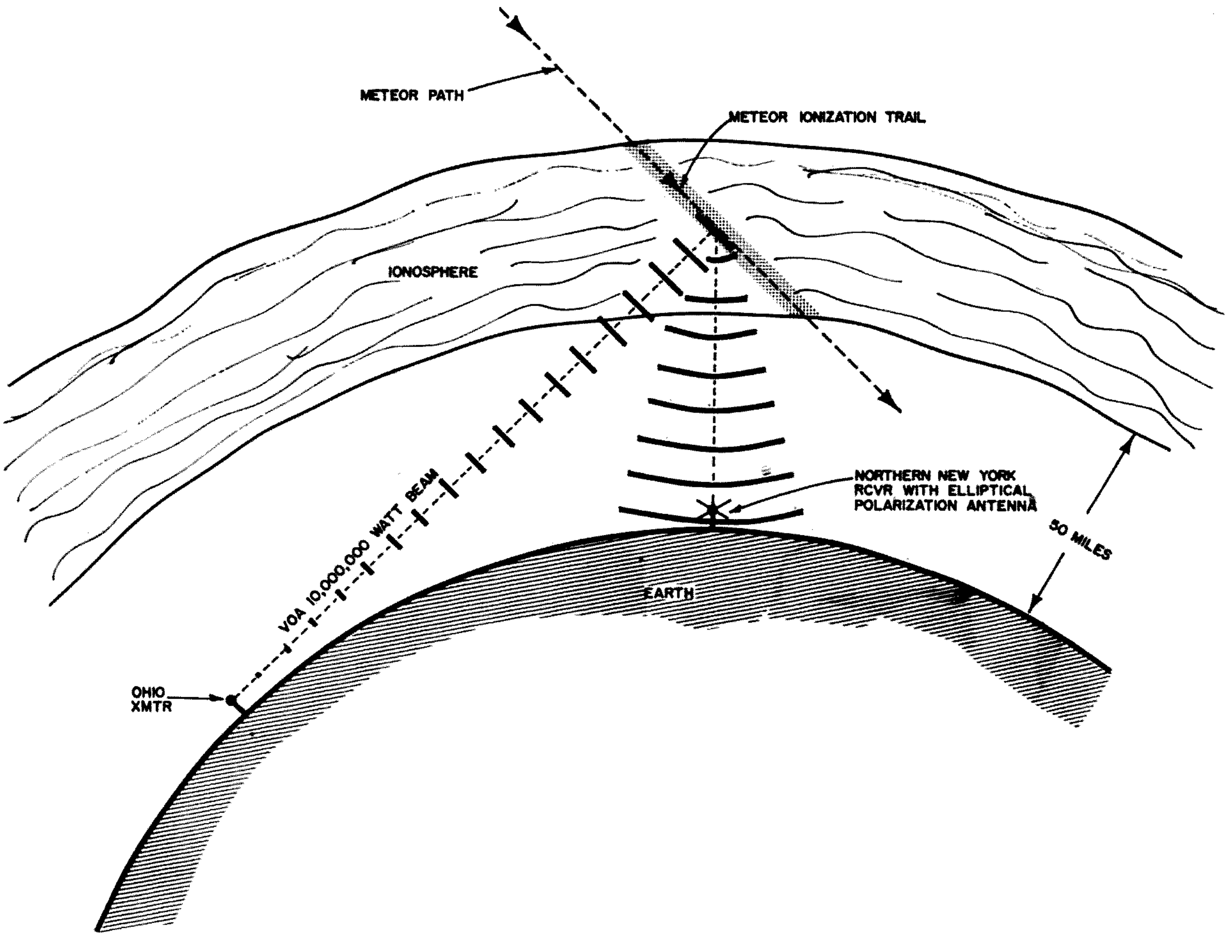

Fig. 1. Meteor count conditions—the meteor trail produced in the ionosphere increases the scatter signal strength up to a million times the residual level for a few seconds, roughly a few dozen times per hour.

fluttery with strengths from zero to S6 and usable for our purposes.

The beam has to be roughly 50 miles overhead, and only a few hundred miles away from the transmitter. Then the only signal heard from the VOA will be the random scatter.

If a meteor trail exists in the *10,000,000* watt beam area overhead, it will boost the VOA signal that is received. While the S-meter bounces up, the sound will resemble several rapid pats on a pillow. The meter may bounce over S-9, and drift down during the next five to fifteen seconds. These are real meteor trails, Fig. 1. They are caused by ionization from meteors having speeds in excess of *ten kilometers per second.*

Meteor counts, when 15 meters is unoccupied, can be made within 600 miles of Long Island by tuning into the continuously operated frequency-shift teletype station on 20.908 MHz. This station runs 16 KVA into a vertical antenna for the north Atlantic airplanes. Listening on its frequency, in the CW position, for ten minutes, will usually show several meteor bursts, of extra strength. In less than a second it builds up, and in several more seconds it fades down. This is "piggyback" radar. This is using a strong signal as a reflection means, while you are hiding away from it.

QRP

An S-1 signal from the VOA beam is down about *10 billion* to one. A beat note on that at about ten per cent modulation is *down* another 20 dB. This is, then, down about *one trillion* to one. One *trillionth* of *10 million* watts is *1/1000,000* of one watt, or one per cent of one milliwatt.

Satellite whistles

If a particle in space does not hit the earth's atmosphere, but orbits instead, something new is added. After an eon, the satellite's orbit will be small and nearly circular and its speed will have approached nearly

five kilometers per second. This means that it does *not* have the energy to make a big ionization trail and will hit the atmosphere at a flat tangent, rather than driving into it.

Under such conditions, I found that the ionization trail made by the particle collapses within about seven meters or fifty feet. The sand or particle is orbiting over the surface of the atmosphere at roughly 5,000 meters per second. Thus, the reflection, from its brief ionization trail, from any given point in space, may be mostly dissipated within *1/700th* of a second.

In contrast, when an intersection meteor trail is able to bump up the S-meter, it has an ionization trail which is several kilometers long, **Fig. 1.** The tonal effect in the receiver from such a meteor is only deep rumbles, similar to distant thunder. It takes high fidelity, good through 2 Hz, to hear and show it on a scope pattern.

However, the grain of sand, with its small ionization trail, **Fig. 2,** at 13 meters wavelength, can be considered as a moving half wave reflector. If it can reflect enough signal, from its one-hundred-thousand-of-a-watt interception to the receiver, it can make an interference with the weakly scattered signal. This interference flutter rate cannot exceed the difference in the number of wavelengths changed per second.

On about 21.500 MHz an orbiting grain of sand burning-in will be flutterable up to approximately 777 Hz. The sand, at about 5,000 meters per second, can increase the length of the path of the signal to it, and then to the receiver, **Fig. 3,** by not more than 10,000 meters per second. By dividing 10,000 by the wavelength of 13, there is a maximum possible tone near 777 Hz, a good CW tone.

Taking the count

If the receiver and antenna system are not the best, take some amateur measurements. Spot 21.485 MHz or 21.650 MHz by your transmitter's VFO harmonics. Use a receiver selectivity which only slightly muffles voice signals on AM. Use any tone control to reduce tones well over 1,000 Hz. If there is a beam, turn it to get a very weak signal from VOA. Tune in during the morning hours and wait for their idle carriers. Their times vary daily with the ionospheric predictions for the day.

Some months they are not there. Once they have been found, log them on the dial. They are often on again between midnight and 1:30 A.M., as they set up and check out after the night's bandswitching. Conditions are best at night due to slightly less cosmic noises.

As the audio gain on the dead carrier is turned up, whistles of low tones will be heard. None will be over 800 Hz. They will last about one second each. As many as 100 per minute can be counted. As only a few of these will have tones much over 300 Hz, the modern communications receiver will not give a good count. The modern roll off of the audio is at about 300 Hz.

I use a 75A2 receiver, which now has corrected flat audio down to 20 Hz, and usable on the scope down to 2 Hz. Many of the tones of the flutters, so low they are inaudible, can be seen on the scope. As random distribution and satellite speed would

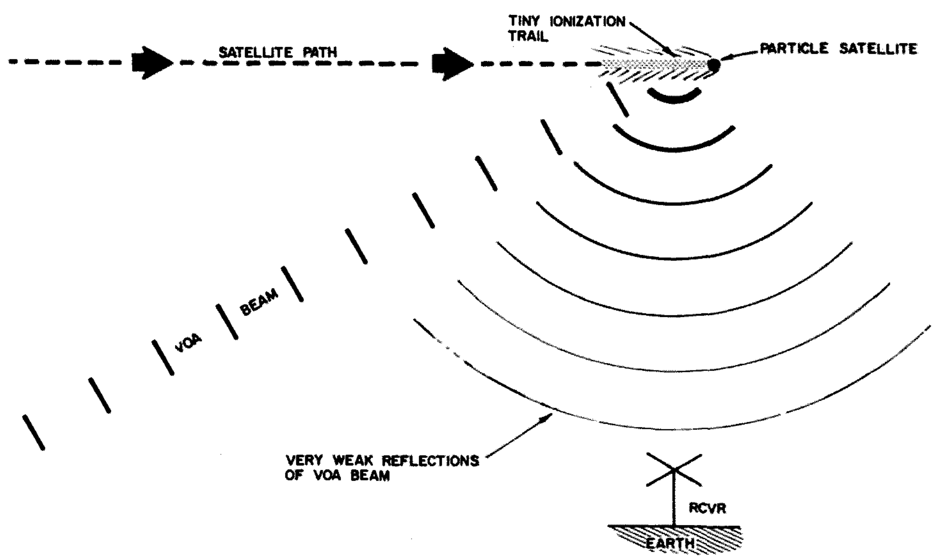

Fig. 2. Satellite count conditions—the small trail collapses so fast that it may be considered as a moving point in space. Often a hundred can be heard in a minute.

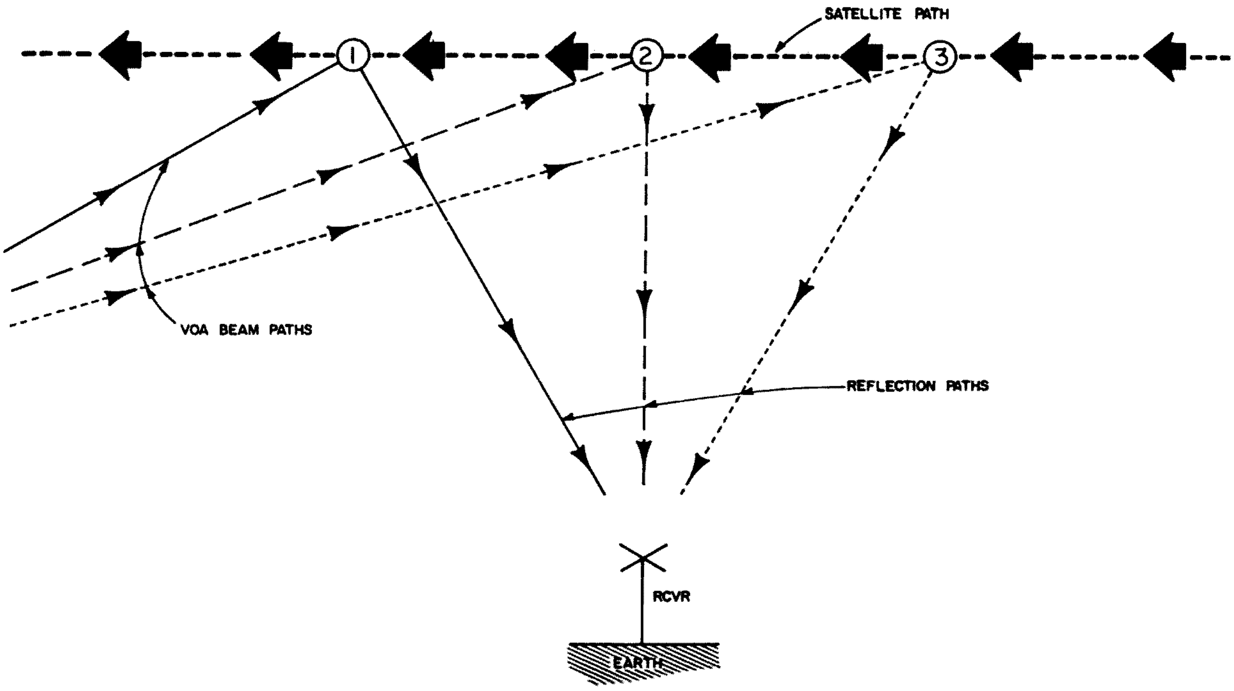

Fig. 3. Doppler shift triangulation—a satellite may produce a lower sideband tone by going from 1 to 3 or a higher sideband tone by going from 3 to 1. In many paths the tone can be sub-audible. Maximum pitches of tones are calculable.

suggest, most tones fall in pitch, although a few low pitched ones should and do rise slightly.

My claims

I believe that I am the first to detect, count, describe and separate these satellites from meteors. I estimate the count in space at 10^{19} around the Earth, with the moon and Mars having almost as many, perhaps more than 10^{18}, with less around moonless Venus and Mercury and many more around Jupiter, Saturn and Uranus which have many moons.

This reception is not a fading 'fluke' of elliptical polarization (having proved this with a special antenna for elliptical polarization), nor a manifestation of the sun on the layers, nor from cosmic rays, nor from meteors.

There is no other practical radar system in use today that can detect these satellite burn-ins on a continuous basis on these wavelengths.

While these whistles have been heard and noted by others before, none of them have indicated that they were caused by natural satellites burning-in rather than by the commonly believed meteor theory.

In another newspaper story I recently predicted that these particles would be found largely around high peaks of the moon. The peaks would first intercept the orbit paths of the particles. However, I expect much of the moon is covered with a "sea-salt-crystalline-flower" crust. This was deduced since the earth has enough sea-salt to spread over its surface 200 feet thick. I expect that there is much "salt" in with the "sand" on the moon.

From my estimations, a moonwalker, standing on its highest peak, would be hit about once a day, or less, by slow orbiting moon satellite particles. In the lowlands, he would get about one hit a year, from a much higher speed meteor.

. . . W2WLR

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Sideband Filters

One of the most important, and least understood, parts of any sideband equipment is the filter. Here is a description of the various types and how they work.

In light of present day developments in single sideband (SSB) transmission and reception, it is felt that the following information relative to crystal-lattice SSB filters and mechanical SSB filters will be of interest to amateur radio operators.

Both SSB transmitters and SSB receivers require extremely selective band pass filters. Most SSB transmitters and receivers incorporate filter networks which act in the frequency range of 100 to 500 kHz or higher dependent upon the carrier-generator frequency.

In an SSB receiver, the sideband filter rejects adjacent channel interference and undesirable mixer products. In SSB transmitters, the signal bandwidth must be limited sharply in order to pass the desired sideband and reject the unwanted sideband residual carrier frequency and spurious frequencies generated in the modulator. The filter used, therefore, must have a very steep skirt characteristic (fast cutoff) and a flat bandpass characteristic. These requirements are met by crystal filters, inductive-capacitive (LC) filters, and mechanical filters.

Crystal filters

Crystal filters have the high Q and excellent stability characteristics necessary for use in SSB receivers and transmitters.

When crystals are employed, they are used

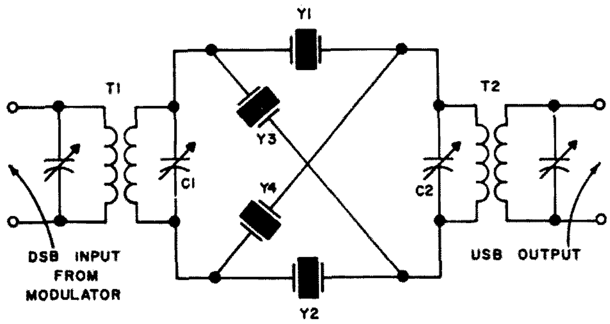


Fig. 1. Crystal-lattice filter, USB only.

in crystal-lattice filter circuits (**Fig. 1**). The filter consists of two pairs of identical transformers, T1 and T2. Crystals Y1 and Y2 are series-connected and Y3 and Y4 are shunt-connected. Each pair of crystals is matched in frequency, within 10 to 20 Hz of each other.

With an intermediate frequency of 100 kHz and upper sideband frequencies of 100.1 kHz to 103 kHz, series connected crystals Y1 and Y2 are 100.1 kHz crystals and the shunt-connected crystals Y3 and Y4 are 103 kHz crystals. Input and output transformers T1 and T2 are tuned to the center frequency of the pass band (101.5 kHz) and act to spread the difference between the series-resonant and parallel-resonant frequencies of the crystals. Capacitors C1 and C2 are used to correct any overspreading of frequency difference under matched crystal conditions. The operation of the crystal-

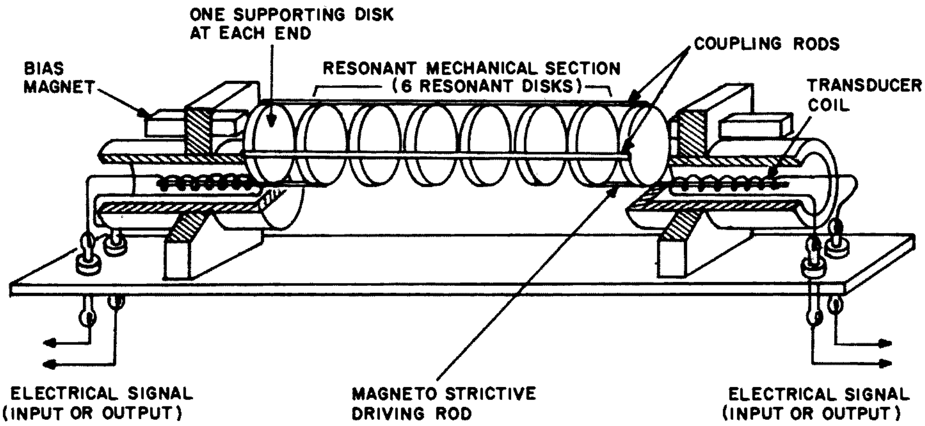


Fig. 2. Elements of a mechanical filter.

lattice filter is similar to that of a bridge circuit. When the reactances of the bridge arms are equal and have the same sign (inductive or capacitive), the signals through the two possible paths of the bridge will cancel out. When the reactances are of opposite sign, there will be a partial transmission through the network. The maximum is transmitted in the pass band at the points where reactances are equal in amplitude and opposite in sign. The insertion loss of a crystal-lattice filter varies from 1.5 dB to 3 dB.

Mechanical filters

The mechanical filter is a mechanically-resonant device (**Fig. 2**) which receives electrical energy at its input, converts it into a mechanical vibration, and then converts the mechanical vibration back into electrical energy at its output. The mechanical filter consists of four basic elements. The four elements are described in order along the signal flow path.

1. The input transducer coil, bias magnet, and magnetostrictive driving rod, which convert electrical energy input into mechanical oscillations (vibrations).
2. The mechanically resonant metal disks.
3. The coupling rods which couple the metal disks.
4. The output transducer coil, bais magnet, and magnetostrictive rod, which convert the mechanical oscillations back to electrical energy.

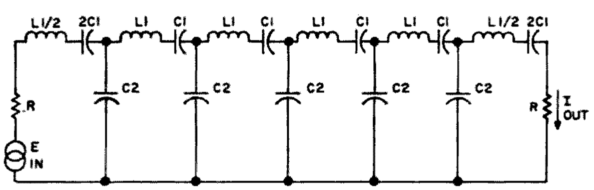


Fig. 3. Electrical analogy of a mechanical filter.

Series-resonant circuits L1-C1 represent the metal disks (**Fig. 3**). The coupling capacitors C2 represent the coupling rods, and the input and output resistances R represent the matching mechanical loads. From this equivalent circuit, it can be seen that the center frequency of the mechanical filter is determined by the series-resonant circuit

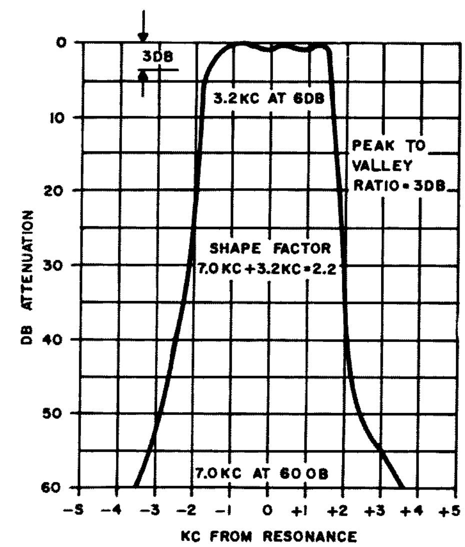


Fig. 4. Mechanical filter, characteristic curve.

formed by L1-C1, which represents the metal disks.

The transducers may be either magnetostrictive devices or electrostrictive devices. The magnetostrictive transducer is based on the principle that certain materials elongate or shorten when in the presence of a magnet field. Therefore, if an electrical signal is sent through the transducer coil containing the magneto-strictive material as the core, the electrical oscillation will be converted into mechanical vibrations of the core material. The mechanical vibration then drives the mechanical elements of the filter. The electrostrictive transducer is based on the principle that certain materials, such as piezo-

electric crystals, will distort when subjected to an electric field. In practice, the magnetostrictive transducer is more commonly used. The transducer converts electrical energy at the input to the mechanical filter and acts in the reverse order at the output. It also provides proper termination for the mechanical network.

Each disk in a mechanical filter represents a series resonant circuit; therefore, increasing the number of disks increases skirt selectivity of a filter. The shape factor, the ratio of bandpass 60 dB below peak to bandpass 6 dB below peak, determines the skirt selectivity (**Fig. 4**). Present filters have a limit of eight or nine disks. A six-disk filter has a shape factor of approximately 1.85; a nine-disk filter has a shape factor of approximately 1.5.

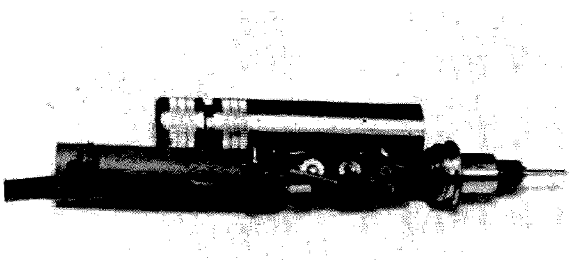
Coupling capacitors C2 (**Fig. 3**) are the equivalents of the coupling rods which couple the disks. By varying C2, the bandwidth of the equivalent circuit is changed. Variation in thickness of the coupling rods also effects the bandwidths of the mechanical filter. The characteristics of an ideal filter would include flat bandpass. However, for practical application, this ideal situation is not attainable. The bandpass characteristic of the filter is termed "peak-to-valley ratio". The peak-to-valley ratio is defined as the ratio of maximum-to-minimum level of the ripple across the useful bandpass of the filter (**Fig. 4**).

LC filters

LC filters have been used at *if* frequencies in the region of 20 kHz. However, generation of the SSB signal in this low frequency range requires an additional mixing stage to obtain a transmitting frequency in the high-frequency range. For this reason LC filters have had relatively little application.

. . . WB2GYS

Voltage-Doubler RF Probe



The voltage-doubler rf probe. This unit is built into a Mallory 100-A extension jack. The probe end is made from a Klipzon #33-402 BU with an earphone tip jack cemented into the test prod.

The following is a description of an rf test probe which can be used to detect very small rf signals in a receiver *if* strip. It will detect signals which do not give any indication on a regular one-diode test probe.

The probe can be made with parts obtained in any radio store. It is built into a Mallory 100-A, two-way extension jack used for earphones. The container is a two-piece nickle assembly with built-in clamps and an insulated paper tube which will slide over the parts to prevent shorts to the shell. It costs $1.50.

The hole where an earphone plug is normally inserted is reamed out with a number "J" drill so that a black bakelight Klipzon test probe fits tightly (Klipzon #33-402 BU). The self-holding point was removed because the series capacitor could not be soldered to it, and was replaced with an earphone tip. If the exact drill is not available, any error in assembly can be corrected by cementing the parts.

The diodes, capacitors and resistor were mounted on perforated board using small rivets. The whole assembly was attached inside the jack housing after removing the insides. The rugged construction of the probe is highly satisfactory for bench work because it can be dropped without damage.

Signals from the probe can be fed into a VTVM on the low volt scale for sensitive measurements. The reading of the VTVM will be a peak-to-peak voltage reading of the rf signal being detected. It is very valuable when tuning up a single-sideband transmitter signal coming through the filter; in fact, it is hard to get along without one.

. . . W6BLZ

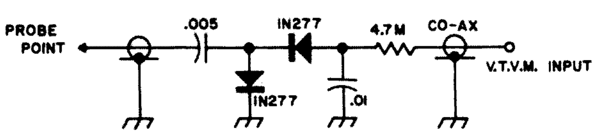


Fig. 1. Schematic of the voltage-doubler rf probe.

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The Two-Meter Groundplane as a Gain Antenna

A groundplane is a unity-gain, omnidirectional antenna.

So much for Lesson 1. The meat of this article, Lesson 2, will shoot down what you learned in Lesson 1. Because virtually any vertically polarized omnidirectional antenna can be used to provide gain and directivity *selectively*—without modification of the antenna itself.

To many, a true omnidirectional antenna represents the optimum approach. For the amateur who operates in the center of a metropolitan area, or the hilltop ham, or the centrally located net control—what could be better? But—what about the guy who lives between two cities and wants good, broad coverage in only two directions? Or the fellow at the foot of the hill who wastes all that rf by dumping half his output into it?

An omnidirectional antenna can still be the answer, but employed to provide gain where the action is.

The secret is not in the antemia itself, but rather in the mounting of the antenna. *Don't mount it atop a mast.* Place it near the top of a mast or tower, and adjacent to it so that the tower or mast itself becomes a part of your antenna system. Learn two simple rules and you can design your omnidirectional antenna to give gain in practically any direction or directions you choose: The first rule is that for each quarter wavelength you space the vertical radiator of the antenna from the tower or mast, you get one major lobe. And the second rule: The bigger the mass of the supporting structure, the wider the frontal and side lobes. Consider the radiation pattern of **Fig. 1.** The solid round dot at the center represents an antenna supporting structure. If an omnidirectional antenna were mounted at the top of the structure, the pattern would be roughly circular. The broken line represents this pattern at a relative field strength of 1.0. If the same antenna were to be moved from the top to the front of the tower and spaced a quarter wavelength from it, the pattern becomes more or less like that of the heavy asymmetrical line. (This is assuming the tower is between eight inches and a foot in diameter adjacent to where the antenna is mounted.) In the sketch, the antenna is represented by the small circle above the center dot.

As shown, the result is an excellent 180-degree signal with no wasted rf off the back. And the bonus is a 30-percent increase in signal strength over 150 degrees of that half-circle. Naturally, this city-side amateur isn't getting something for nothing; whatever he gains in one place, he loses in another. This can be demonstrated by thinking of the broken line in the sketch as a closed loop of string. You can manipulate the string and change the configuration of

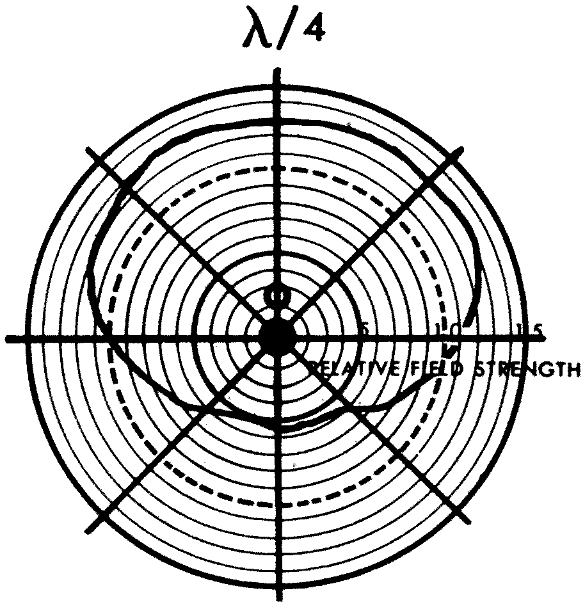

Fig. 1.

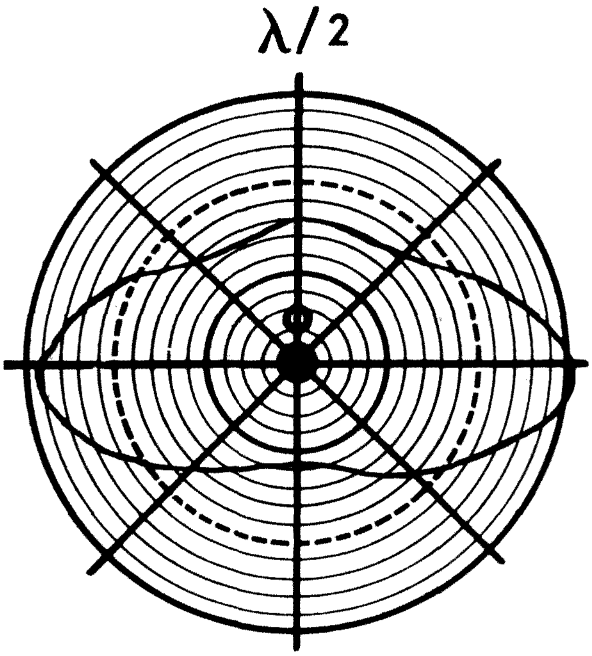

Fig. 2.

it, but for all practical purposes, the size remains the same.

For the amateur who wants good coverage in two general areas spaced roughly 180 degrees apart, the best approach would be to mount the antenna a full half-wavelength from the support structure. A typical radiation pattern from this mounting method is shown in **Fig. 2.** It should be borne in mind that the mass of the tower affects the pattern substantially. A mast would yield a pattern with sharper, thinner lobes—more gain at the expense of horizontal angle of radiation. The half-wave pattern shows that the signal is reduced by 20 percent (from a top-mounted vertical) in a 90-degree area off the front of the antenna, and by about 35 percent in a 60-degree area off the back. But it is increased by as much as 150 percent laterally.

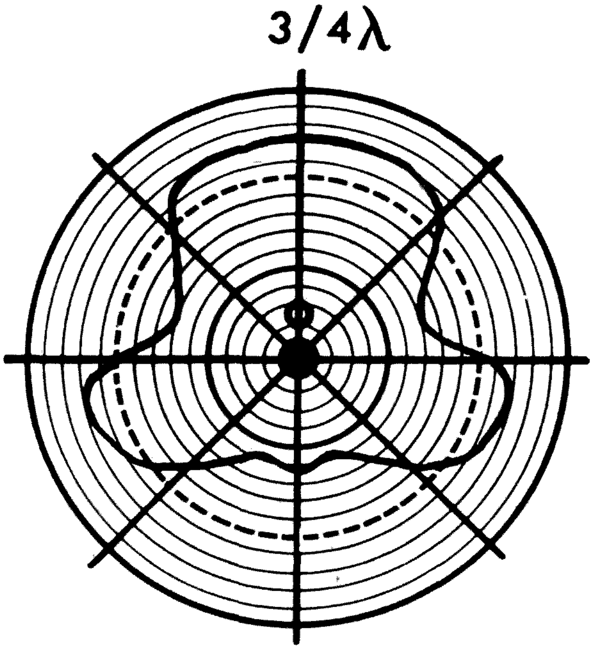

Fig. 3.

A sort of cloverleaf effect can be obtained by spacing the antenna three quarter-wavelengths from the tower. As shown in **Fig. 3,** it results in a very broad frontal lobe with uniform gain over about 80 degrees. The two nulls slightly forward of both sides is compensated for by the gain just rearward of both sides.

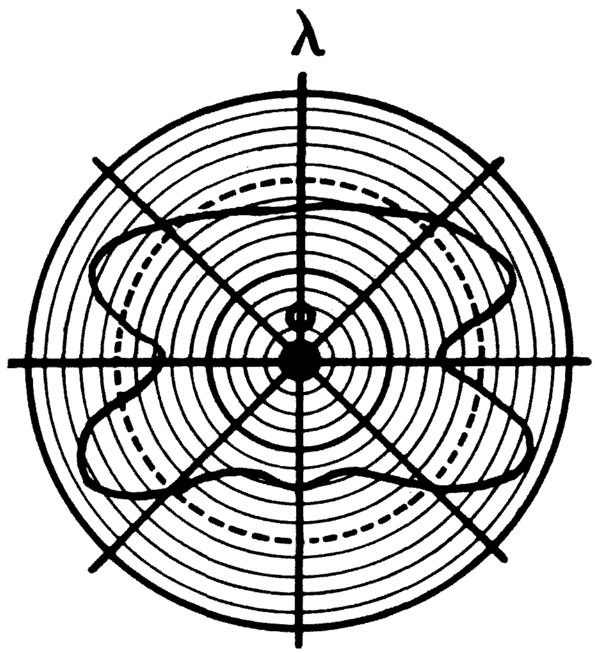

Fig. 4.

It is probably impractical to consider mounting the antenna more than three quarter-waves from the tower. On two meters, a full wavelength would be in the neighborhood of six feet. But the sketch of **Fig. 4** gives a pretty good idea of what the pattern would look like.

The important thing is that the theory is not restricted to any frequency. The patterns remain the same regardless of whether the operation is on six meters or 420 MHz. And the radiation patterns gradually shift from one to the other, so by experimenting with varying spacings, practically any desired effect can be achieved.

. . . K6MVH

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RF Insertion Amplifier for 2 Meters

If you're having trouble driving that final on two meters, try this insertion amplifier. It will provide up to 20 watts output with a minimum amount of drive.

Things get tough when you get up into the VHF-UHF range. You often get to 144 MHz and find everything running nicely, except that you haven't enough power to drive that final. You even thought about using two tubes in push-pull for the final, but now you don't even have enough drive for one. This has happened to me plenty of times in the last thirty years.

An insertion amplifier can be a good answer. It works just like the name says. You insert it between the exciter and the final, for example, to boost the drive to the final. You can also use it in the design of a complete rig, of course. This one will accept an rf input from ⅛ watt to a watt or so, and put out from several watts up to 20 or more, depending on the drive and dc input.

The 8156 as an insertion amplifier

The 8156 is the baby brother of the 7984. Both are G. E. tubes and my favorite tubes for 2 meters. They are both rated for use up to 175 MHz. My only complaint is that while the 7984 costs $5 and puts out 50 watts, the 8156 costs $4 and puts out only 20. The 8156 is hard to beat at this price.

If you are interested in an amplifier with lots of gain which will put out 20 watts on 2 meters and has a lively plate dip, this is it. See **Fig. 1**. Another attraction is the socket. It uses the same connections as the 7984. It is also very sensitive to small signals (transmitted) and can be made part of an exciter if you wish. It should, perhaps, be attached to the final, though, as it has a 12-volt filament.

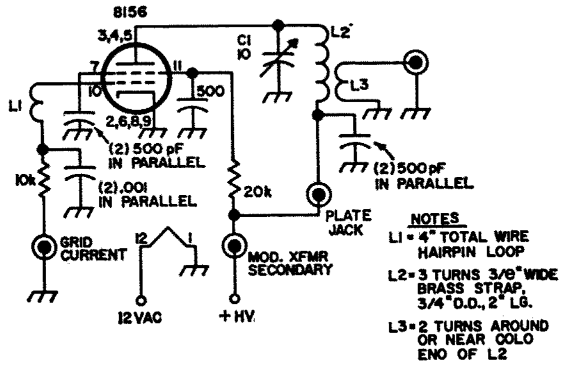

Fig. 1. If you are interested in an amplifier with lots of gain which will put out 20 watts on 2 meters, this is it.

The plate dip, when using only ¼ watt drive, is from 100 mA down to 35 mA. You can get a good 6 watts out from the ¼ watt drive; which is a gain of some 24 times in power. If you push it, the gain and efficiency will both go up. At 20 watts dc input, the output is almost 10 watts. This is not maximum efficiency, but we are only concerned with an insertion amplifier for step-up purposes from a low-power exciter.

For most applications in driving a final amplifier in the 50 to 100 watt range, the rf power output from the 8156 will be plenty. You can go from a watt or so up to 20, which is very useful. You can also modulate it for use as a low power transmitter, using it for 5 or 10 watts output until you can get that 25-watt modulation transformer and the 50-watt final.

You can put a 7984 directly into the socket of the 8156, but you will have to shorten the grid loop a little. That's about the only

change needed. The plate has a little higher capacitance also, but should stay in the 10 pF range of CI.

One note: *do not use one of those black molded-mud sockets on 2 meters.* I keep talking about these things, and yet time and again, I get stuck with one. Low-loss 12-pin sockets just aren't available in the stores. So, I put in a "black" socket, and what trouble *that* gave me; I spent more than 2 days trying to get a decent plate dip. You understand that when I talk about a plate dip, I am using this as a reference for a high Q plate circuit. If you leave the drive and tube voltages alone, the dip will be a direct indication of the Q of the circuit. There is a lot more to this, of course, but this will give you over 95% of the desired test results.

Almost desperate, I finally had the luck to hear a little crackling noise and see a thin line of blue smoke rising up from the vicinity of the plate side of the socket. Pushing the plate and screen voltage up, and leaving the plate dipped so that a maximum of rf voltage developed between pins 3, 4, and 5 (all plate pins), and the grounded socket rim, an arc soon developed and that was that. You should see that socket. It looks as if you had held a match under it.

Taking one of the more low-loss 12-pin sockets out of a perfectly good piece of low frequency equipment in the shack, I replaced the black one. Without any other changes, the plate dip went from 70 mA (out of 200) down to 50 mA. Some difference!

Now things began to move. I could get a 50% plate dip with only 150 volts on the plate. And, about 50% efficiency with about 10 watts out. Note that is with only ¼ watt of drive. No self oscillation occurred at any time using the low-impedance type LI on the grid.

I was now able to find out exactly how much drive the big final needed for absolute maximum rf out, by controlling the plate voltage of the 8156, and also could run my crystal vfo exciter at very low, stable power.

As a final check; there is now a nice plate dip of from 100 mA down to 35 mA. This is good.

The 5763 as an insertion amplifier for 2 meters

If you have some 5763 tubes on hand, they will do the job for you; though not as well as the 8156. The 5763 is indicated for maximum ratings to 50 MHz. But, let's see what it can do in spite of that. A number of days on the bench were the result of that decision. I could get a power gain of between 10 and 15 under certain conditions, but it seemed reluctant to "go" on 2 meters. Working carefully with the grid and plate circuits, the best plate dip I could get on 2 meters with about ½ watt drive, was from

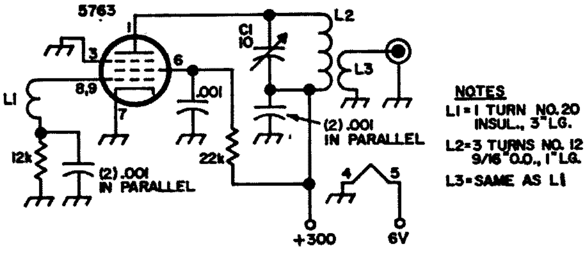

Fig. 2. Using the 5763 as an rf insertion amplifier for 2 meters. You may have to boost your power to get sufficient drive.

40 mA down to 34 mA, and about 1.5 watts out.

The poor plate dip on resonance seems the best indication of its sluggishness on 2 meters. If you have some 5763 tubes available and don't feel like getting an 8156 just yet, you can use the 5763 and perhaps boost your power enough for the drive you need. **Fig. 2** shows the circuit; which is not complicated.

Pay attention to the grid circuit, though. I spent lots of time on this one, and another like it for the 8156. I was able to set up a 2-meter tuned-grid circuit in spite of the large input capacitance and lower frequency ratings, but when using a tunable-grid circuit, more grid current was lost on applying dc screen and plate power than with a fixed tuned 11, and, even worse, self-oscillation showed up. So, I went back to the grid loop. The entire "grid coil" is a single piece of wire 3 inches long and bent into a U.

This does not allow for a cable link from the exciter, but I have not been able to get a cable link to equal the efficiency of the close-coupled low-impedance loop feeding directly into the grid.

This unit, with 250 volts on the plate and 40 mA of current, will put out a watt and a half, if everything is tuned up properly. It is a useful piece of equipment, but I'm afraid that today the 5763 is a little out of date for VHF.
The 8156 unit is far superior.

. . . K1CLL

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2 Elements Spaced a Quarter-Wavelength

The author describes a simple coaxial feed system for a 2-element beam antenna which allows simple electrical pattern selection.

The author desired a simple beam antenna for 15 meters which could be made from wire elements strung between some trees and still provide various directional patterns.

These requirements were satisfied quite easily by a driven, two-element array with quarter-wavelength spacing. Quarter-wavelength spacing of two driven elements represents a very interesting case because of the variety of directional patterns which can be obtained without any complicated impedance-matching problems. This is due to the fact that at quarter-wavelength spacing the impedance of each element is almost the same as its free-space impedance, while at closer spacings the presence of each element severely affects the impedance of the other element.

The three directional patterns which can be obtained from such an antenna are shown in **Fig. 1.** The cardioid patterns will provide gain of 4-5 dB while the bi-directional pattern in (c) of **Fig. 1** will provide about 3-dB gain.

The antenna which the author constructed for 15 meters is shown in **Fig. 2.** RG-59/U is used to feed each antenna as well as for the quarter-wavelength phasing section. RG-59/U was chosen because when the two feedlines are effectively paralleled by the pattern selector switch, an impedance of 36 ohms will result. When RG-58/U is used to the transmitter an SWR of about 1.5 to 1 should result.

Actually, the author measured an SWR of closer than 2.0 to 1, probably because of some slight mismatch between the RG-59/U and the dipoles. The 2.0 to 1 SWR should cause no difficulty as far as transmitter loading is concerned and the actual power loss in the short length of RG-58/U used between the pattern selector switch and transmitter is insignificant.

An alternative connection between pattern

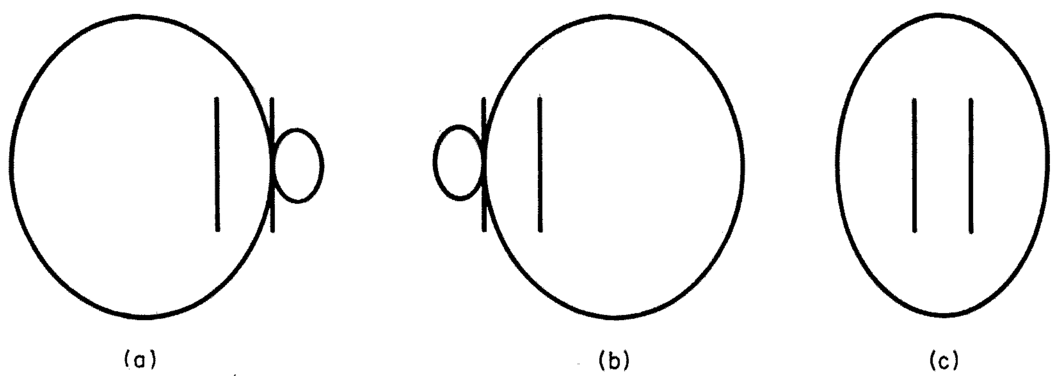

Fig. 1. A representation of the three directional patterns possible. (a) is the cardioid pattern obtained with a 90-degree phase difference between elements, (b) is the same pattern switched in the opposite direction, and (c) is the pattern of zero-degree difference between elements.

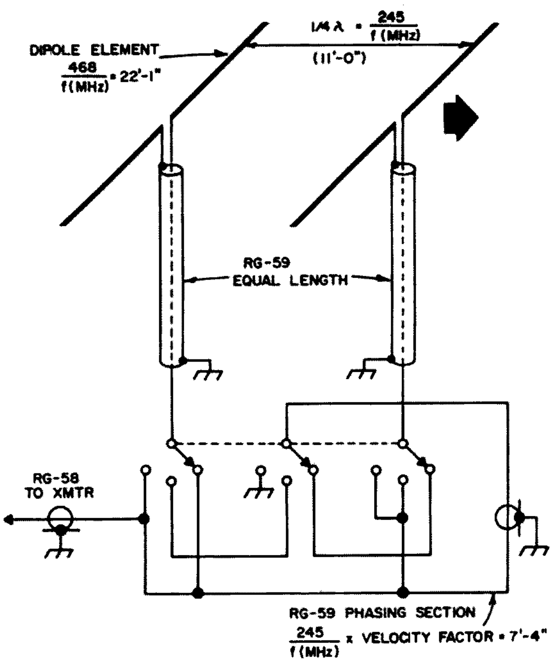

Fig. 2. The pattern selector switch. Maximum radiation is in the direction shown by the arrow for the switch position show. When the switch is in the bidirectional position, the antenna is also grounded through the quarter-wave phasing section as a lightning protection feature. The dimensions shown are for 15 meters.

selector switch and transmitter is shown in **Fig. 3** for those who insist upon the lowest possible SWR.

The same scheme of feeding and phasing the antennas could be used with an antenna dimensioned for another band or with vertically oriented dipoles. For horizontal antennas, they should be elevated at least a quarter-wavelength to insure that the impedance of the dipoles is 60-70 ohms.

For someone who is just interested in a beam pattern in one direction, the simple feed system shown in **Fig. 4** can be used. The RG-58/U feedline should be limited to

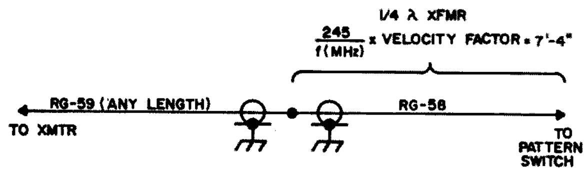

Fig. 3. An additional matching circuit which can be placed between the pattern switch and transmitter to improve the SWR. It replaces the RG-58/U phasing line shown in Fig. 2.

about 100 feet, however, because it may operate at an SWR of up to 2:1.

This type of antenna is certainly not new but the type of feed system devised by the author considerably simplifies construction. The directivity is not as sharp as a two-element parasitic-type beam but it provides almost the same gain in several directions at a minimum installation cost.

. . . W2EEY

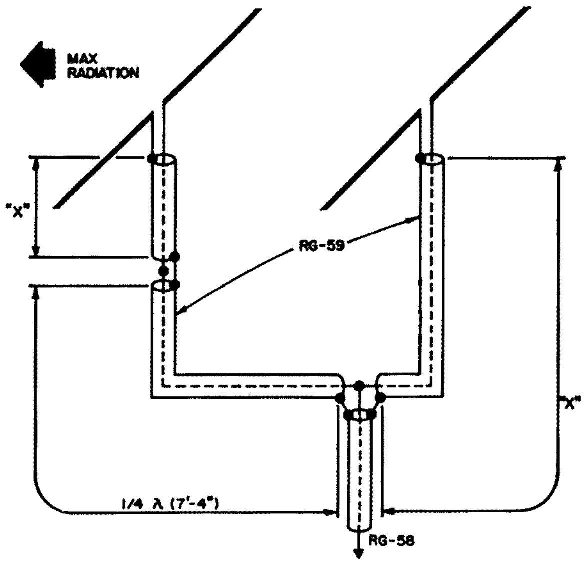

Fig. 4. Feed system for a fixed-direction beam pattern. The sections marked with an "X" are made up from RG-59/U and may be any convenient, but equal, lengths.

Hewlett-Packard Application Note

The new application from *H-P* entitled, "Step Recovery Diode Frequency Multiplier Design" (Hewlett-Packard AN913) should be very interesting to the VHF/UHF set. This note gives step-by-step procedures for designing UHF and microwave frequency multipliers. Examples describe design procedures for a X10 multiplier with an output of 2 watts at 2000 MHz, and a X5 multiplier with a 2000 MHz output of 5 watts (2304 MHz enthusiasts take note). Another example describes a X5 multiplier that achieves 10,000 MHz output at 180 mW.

This Application Note includes design aids in the form of full-page graphs that can be used to find the optimum circuit components. Methods of matching the multiplier input and output impedances to source and load are described and techniques for compensating the circuit for temperature changes are also discussed. For your copy, write on your company letterhead to Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304.

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Wide-Band Baluns the Easy Way

The desirability of using a network or transformer to feed a balanced coaxial line is well known and has been widely discussed. Single-band baluns have been well covered with this in mind. A variety of broad-banded, ferrite-cored baluns have recently come on the market. I had a need for such a 1:1 wide-band balun to go with a three-band antenna and none was immediately available; a little research produced a simple, cheap and easily constructed balun which met all of the requirements, electrically and mechanically. It covered the 40, 20, and 15 meter bands, using 20 meters as the design center.

Not having any formulas to cover the resonant frequency of scramble-wound coils of coaxial cable, the time honored cut and try method was used. A number of turns of RG-8/U cable were coiled up using the diameter of the desired finished balun. The resonant frequency was then checked with a grid-dip meter. A little trimming was then necessary to obtain resonance in the 20-meter band. The resultant coil consisted of ten feet of cable wound in five turns.

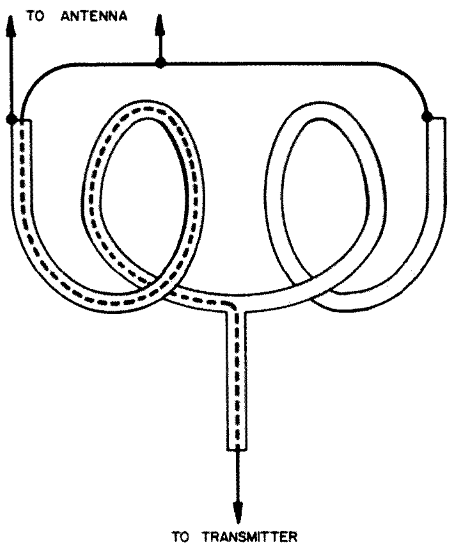
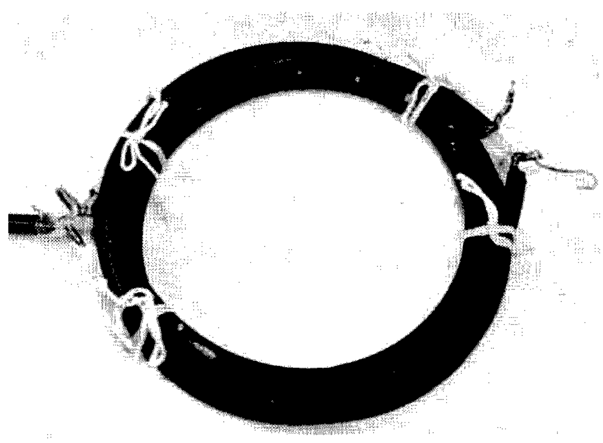


Fig. 1. The 1:1 balun constructed from a length of coaxial cable. When designed for the center of the desired frequency range, it will cover a 3:1 frequency operating range. The unit described here for 40, 20 and 15 meters consisted of two 66-inch lengths of RG-8/U.



The completed coaxial-cable balun used by K4ZZV on 40, 20 and 15 meters.

The odd number of turns were purposely worked out so that the center-tap feed point would come on the opposite side of the coil from the load point for mechanical reasons. The five-turn coil was then cut in half, and the inner conductor and the shield were connected according to the diagram and then recoiled. In actual practice, the original coil was scrapped and two new 66-inch lengths of cable were cut. This allowed for three inches to be skinned back on each end to make the connections and still maintain the original length. The joints were carefully soldered and taped to keep out the moisture. The coil was then bound with lacing cord, and it was ready for installation using the shortest possible leads to the antenna.

Measurements on the experimental 1:1 balun shown in the photo using a 50-ohm dummy load gave SWR readings of 1.34:1 on 40, 1.15:1 on 20, and 1.43:1 on 15 meters. This was considered reasonable so the finished product was installed at the antenna. It is still necessary to tune the antenna when using a balun transformer as it works much better looking into a non-reactive load. Its purpose is to take the rf off the shield of the coaxial feed line when feeding balanced antennas and make the antenna the only radiating device in the system.

. . . K4ZZV

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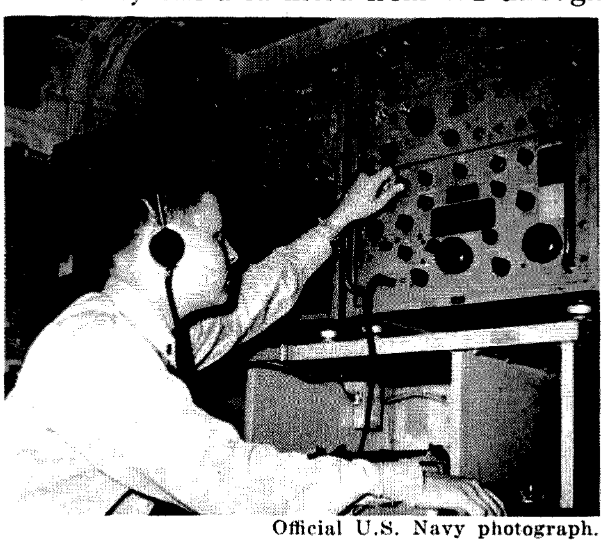
Hamming—The Navy Way

Radio amateurs are the same the world over but what does an amateur radio station mean to the men aboard our fighting ships of the U.S. Navy? The answer is told by the men who operate these stations and at the same time you will see some of the "shacks" and the ships they are on.

Back in the early 60's, amateur radio was only used by a few ships in the Navy, but today this has changed. Radio amateurs are encouraged to have amateur radio activity aboard the ships and the only limitations imposed are those necessary for security requirements. The Navy instructions emphasize a balanced program covering the various areas of amateur interests, since such activity promotes the morale, recreational, public service and good will aspects of amateur radio. With this encouragement, the list of stations has increased from a few to more than 645 licensed amateur maritime mobile stations with every call area listed from W1 through WØ; with some KC, KH, KL, KM and KZ prefixes included.



Official U.S. Navy photograph.

Ensign E. S. Gregg K1IJG setting up a phone patch in the communications center of the aircraft carrier *USS Princeton*.

With Long Beach being the home port of many Pacific Fleet ships, we were fortunate to see some of these maritime mobile stations; so let us take you on a tour to meet these amateurs and see their "shacks" and the equipment they use. Some "shacks" are large, some are small. The size of the "shack" and the limitations of space available depend upon the size of the ship. Some ships use commercial amateur radio equipment while others use the Naval radio equipment aboard ship; providing the equipment is operated within the F.C.C. rules regarding amateur operations. The commercial amateur radio equipment is purchased by the crews of the ships from the Recreation Fund; a fund derived from the profits of the Ship's Store and Soda Fountain.

As your guide on this tour we will go aboard several of the ships now in Long Beach and our first visit will be to the Amphibious Assault Carriers *USS Princeton* (her nickname is "The Sweet Pea"). The *Princeton* recently completed a deployment operation; and with her mission completed, the crew looked forward to homecoming. It was at this point that amateur radio entered the picture. The executive officer, Commander T. N. Thompson, a former commander of Little America in the Antarctica, well remembered the tremendous value of KC4USA in keeping morale high for lonely, isolated navymen. Commander T. N. Thompson asked for and received permission to commence amateur operations after leaving Hawaii. Ensign E. S. Gregg, the Education and Training officer, started operations on the amateur bands using his call, K1IJG/MM, with Navy communication equipment. Assisted by Air-

man Apprentice N. D. Crouch, WA4BTO and Petty Officer D. Palmer, the results were so successful that over 150 phone patches were completed in a three-day period with calls going from Los Angeles to New York City. Some problems created by rapid changing skip were encountered, but so many land-locked hams offered to help out with the traffic that some offers had to be turned down. The entire crew was so gratified with the results that the Captain is now considering a request to purchase commercial amateur radio equipment in anticipated formation of a radio club and the building of a new ham station. This will increase the interest of radio amateur activities with more emphasis on phone patching.

The *USS Topeka,* a guided missile cruiser, is berthed close by, so let us go aboard and meet the two licensed radio amateurs: Chief Radioman Bob Middleton WA4RDE, and Lt. Pat Roth K3EUE. The present amateur radio station K3EUE/MM, was activated in March, 1967 and has worked three continents, twelve countries and 25 states. Many phone patches have been run for members of the crew from the ship to the Long Beach Naval Base Station, WB6GUI and the Westcar Amateur Radio Net, which specializes in phone patching. The Westcar Amateur Radio Net has stations from San Diego, California to Seattle, Washington always on standby to pick up traffic from Navy ships. The *Topeka* has had amateur radio activity since 1961 when it was attached to the Atlantic Fleet. When the ship was transferred to the Pacific Fleet, late in 1961, the amateur radio interest was so amazing that it served as the most effective single training aid for radiomen and electronic technicians. At this time, Chief Middleton now has a code and theory class of 25 prospective radio amateurs from the ship's crew, who will soon receive their F.C.C. amateur radio licenses.

Our next ship on the tour is the repair ship *USS Hector,* named after the famous Trojan Warrior. The *Hector* is a floating shipyard which is able to move with the fleet to any part of the world and is capable of repairing almost any equipment or part of any ship in the Pacific Fleet. Even though a busy ship, the "ham" actvities are not neglected. The radio amateur station WB6SUV, is under the supervision of Chief Petty Officer, Vic Jeter WB6SUV assisted by Chief Petty Officer Dave Wood WØJOB, and Petty Officer

Official U.S. Navy photograph.

Chief Radioman Bob Middleton WA4DRE, working some DX in the ham shack on the cruiser *USS Topeka*.

Paul Himmelberger K3THZ. The station started operations in April 1966 and has since been very active on all amateur bands. On a recent return cruise to the states the *Hector* amateur radio station made some 1200 contacts and handled over 500 pieces of traffic; many of emergency nature, for the ship's crew. The international goodwill aspects of amateur radio was not neglected with the station logging some 50 countries on all continents, and some mighty choice DX. The welfare and morale traffic was paramount and the *Hector* claims a first in that the station maintained schedules with her home port, Long Beach, from the start to the finish of the cruise. This was due in a large part to the efforts of the operators at the Long Beach Naval Base Radio Club Station, WB6GUI, who handled the traffic through that station. Radio amateurs are cordially invited to visit the *Hector* and the ham station at various ports-of-call along the west coast of California to Washington. It is possible to arrange for hams to come aboard for short cruises of a few days to see how the *Hector* operates at sea, and to observe maritime mobile operations.

Before continuing with the tour of the ships, let us look in on the Long Beach Naval Base Radio Club Station WB6GUI, which is the key station of communications for many ham stations aboard the ships. This station, under the supervision of the Special Services Department, started operations in 1963 and,

A busy night at WB6GUI, the Long Beach Naval Base Amateur Radio Station. Chief Vic Jeter WB6SUV of the *Hector* is at the Model 19 Teletype machine, while Seaman Gene Brockman WA9LRO, of the aircraft carrier *Yorktown* passes traffic.

since then, has handled thousands of phone patches and traffic for the Pacific Fleet. This station is for the licensed radio amateurs of the Naval Base and the fleet. When ships are in port, the radio amateurs of these ships operate the station when on liberty. Several hundred Navy men of all ranks have operated WB6GUI since the station was opened in 1963. Many nights they have spent hours upon hours of their own time to complete phone patches so that men at sea could talk to their loved ones at home. This is a rewarding experience for these men as they know someday they may be out to sea and wish to talk to their families. Phone patching is a prominent part of the operations of WB6GUI and the navy way is to say, "a job well done."

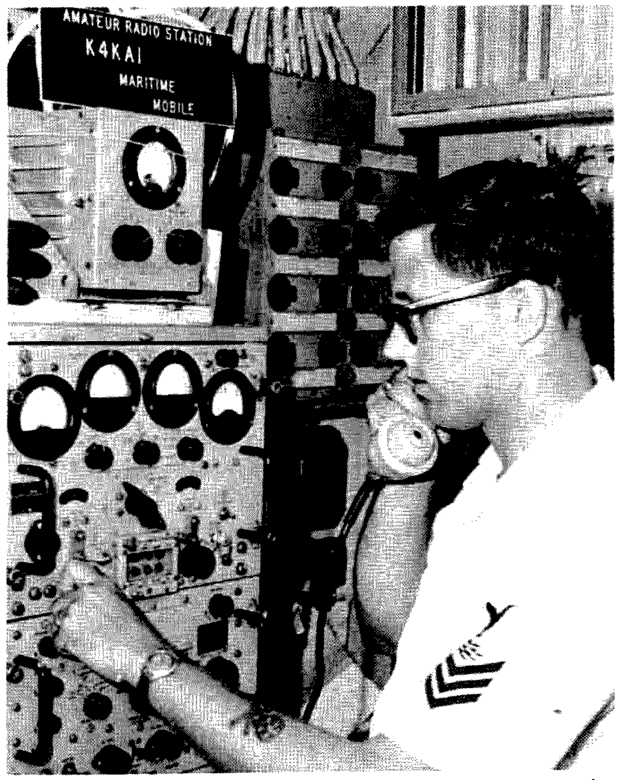
Now that our visit is completed at the Long Beach Naval Base Radio Club Station, WB6GUI, let us continue with the tour to the worlds first Nuclear Powered Guided Missile Frigate, the *USS Bainbridge*. The ham shack uses the ships navy communications equipment. There are three radio amateurs aboard, Radioman Charles L. Davis WA8BPY; Radioman Donald E. Atkins K5KLE; and Lt. Paul Johnson KØJWX. The *Bainbridge* has been a very busy ship in the western Pacific area and radio amateur activity has been very little. On their next cruise the station will be operating and looking for contacts to all parts of the world with phone patching included.

Docked close by is the destroyer *USS Edson*, so let us go aboard and see one of those "fighting greyhounds" and look in on the ham shack. Our visit was to see how radio amateurs operate on the smaller ships such as the *Edson*. To our amazement we found that even with limited space, the shack was as businesslike and efficient as in your own home. The *Edson* amateur radio station has been operating since January 1967, and it was thru the efforts and foresight of Lt. Commander C. J. Stuart K6AXY that amateur radio operations paid off when the ship returned from the western Pacific recently, and 120 phone patches were completed in four days. Chief Radioman Bob Sinclair KH6FLY, and Electronics Technician W. R. Waugaman ran the phone patches through the support of 28 land-based radio amateurs without any problems. This was the first time phone patches were made on the *Edson* and at first the reaction was indifference. During the earlier period of the phone patching, the operators had to look around in the crew to make a phone patch but two days later the crew were waiting in line to talk to relatives and friends back home. When KH6-FLY/MM was first opened earlier this year, the dx was from all parts of the world and in returning from the western Pacific recently, the station worked the North Pole, (weather station), Australia, South America and Alaska on both CW and phone. Nine states were also worked and four, Texas, Kentucky, Oregon and Washington, were worked on teletype. This is the first time, as far as we know, that teletype has been used from an amateur station aboard a navy ship at sea. The *Edson* is presently using Navy communications equipment for amateur radio on 10, 20, 40, 75 and 80 meters.

On this tour we have tried to pick out all size navy ships, from the big aircraft carrier down to the small minesweeper, so you could see and read about the ham operations on these ships. Our last visit on the tour is the ocean going minesweeper, the *USS Persistent*. Though small in size (170 feet long and approximately 20 feet across the beam), the

Persistent has an amateur radio station K4KAI/MM which can be heard frequently in any part of the world. It was activated in the latter part of 1965 and the communications equipment is both navy and commercial amateur radio. Very little activity was done on the amateur bands during most of 1966 as the *Persistent* was in western Pacific deployment. Upon completion of that assignment, radio amateur activities got under way when the ship was returning to her home port in Long Beach. K4KAI/MM, with Radioman Sam Yates, began phone patching for the crew. Many phone patches were completed with the help of the hams in the Los Angeles area. Some DX contacts were made on this trip but phone patching was priority.

We have reached the end of our tour of these several ships but the stories from the radio amateurs aboard the ships could be multiplied several hundred times by those amateurs on the ships we did not reach. It is a most significant factor that amateur radio plays an important part in the lives of our navymen at sea. The morale, recreational and international good will part of amateur radio is considered a necessary way of life for the men who roam the seas. The mention of phone patching in each of the ship's stories told here shows the importance to morale and the happiness loved ones get by these phone patch calls. Much credit should be given to the land-locked radio amateurs who night after night assist the ships with the phone patch traffic.



The ham shack and communications center on the minesweeper, *USS Persistent.* Radioman Sam Yates K4KAI at the controls.

Thanks to the Naval officers and navymen for their assistance in presenting this story.

. . . K6GKX

Maritime Mobile Ships

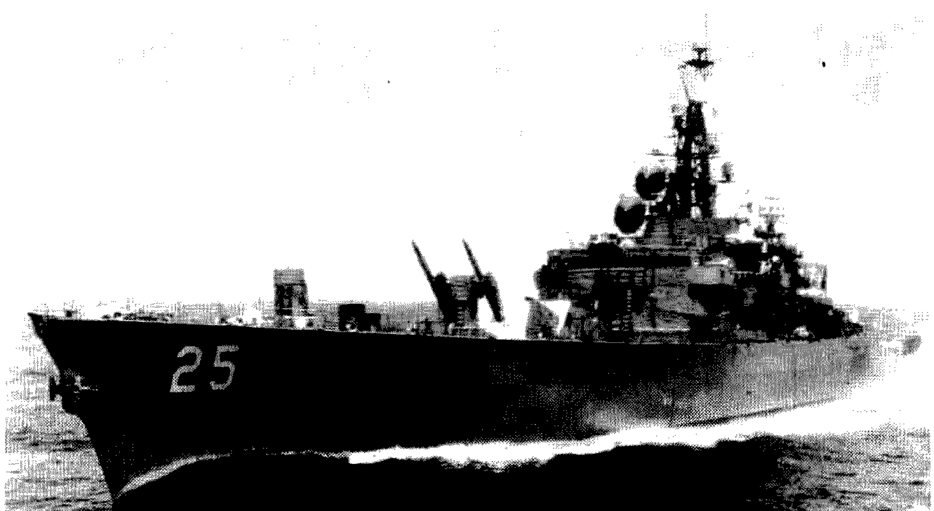
For those of you who are interested in handling traffic and phone patches for the many maritime mobile stations, here is a list of active stations in both the Atlantic and Pacific Fleets along with their call sign(s).

USS

ACME (MSO-5Ø8) WØQQG
ADVANCE (MSO151Ø) K3RYG
AFFRAY (MSO-511) KØFZD
ALACRITY (MSO-52Ø) K3AEP
ALBANY (CG-1Ø) K3MDT, K9MWA, K4WOV
ETHAN ALLEN (SSBN-6Ø8) WB6DCI
ALUDRA (AF-55) K3YDB
AMERICA (CVA-66) K3WUD, K3NLC, WA2SGC, K3PUP, K2LQQ, K6GEM
AMPHION (AR-13) WA4UEJ
RICHARD B ANDERSON (DD-786) WB6EXI, K4SVW, KØPAQ, K7OEG, K8ITC
ANGLER (AGSS-24Ø) K1SDY
ANNAPOLIS (AGMR-1) WA2FLB
ARCADIA (AD-23) K1LZN, WB2FVX
ARGONAUT (SS-475) W8CWE
ARNEB (AKA-56) K3OYB
ASHLAND (LSD-1) W8FZE
ASSURANCE (MSO-521) WA4FIJ
ATAKAPA (ATF-149) K3DTM
ATKA (AGB-3) WAØHOT
AUSTIN (LPD-4) W9AFH
AVENGE (MSO-423) KØLBZ, W9AXX
BAINBRIDGE (DLGN-25) W5SLG
BARRY (DD-933) K1RUZ
BASILONE (DD-824) W2B2TTS
BAYFIELD (APA-33) K8LDO
BEATTY (DD-756) K3QMF
BELKNAP (DLG-26) WB6JTC, K5QFX, WA4SNB
BELLATRIX (AF-62) WB6BRT, WA4BEW
BENNER (DD-8Ø7) K5KWC, K1MEY
BENNINGTON (CVS-2Ø) W5SKG
FRED T BERRY (DD-858) K4OND
BIGELOW (DD-942) WA2CEC
J DOUGLAS BLACKWOOD (DE-219) K3SUC, W3GKQ, W3ELD

BLANDY (DD-943)	WB2QCP
BLENNY (SS-324)	W3YYZ
BON HOMME RICHARD (CVA-31)	KØRWW, K6AYK, WA6BAU, WA8ICM
BOSTON (CAG-1)	WA2BQO, KM6CI
BOXER (LPH-4)	W4PJT
BRADLEY (DE-1Ø41)	K6ZIC, K5UOD, K6AAG
CHARLES E BRANNON (DD-446)	K7YMO
BRIDGET (DE-1Ø24)	K9JII
BRINKLEY BASS (DD-887)	K7BIK
BRISTER (DER-327)	K8DJE
BRUMBY (DE-1Ø44)	WA4OIV
BRUSH (DD-745)	W9EPX, WB6FJY
BRYCE CANYON (AD-36)	K5SLO, WA3BDP, WB6NJB
BUCHANAN (DDG-14)	WØNHZ
BURTON ISLAND (AGB-1)	WA4ZSU, WA8SEJ, KC4USI
BUSHNELL (AS-15)	WA4YWF, W4PSZ, K4VWI, K3PCE
BUTTERNUT (AN-9)	K9BFK
RICHARD E BYRD (DDG-23)	K9KLO
CABILDO (LSD-16)	WA6MVV
CADMUS (AR-14)	W4WZN
CALCATERRA (DER-39Ø)	K1ZBR, WA4JVL
JOHN C CALHOUN (SSB(N)-63Ø)	WA4SOL, WA4SPW, WA4KTZ, K4VUF
CALIENTE (AO-53)	K7LRX
CALVERT (APA-32)	WA6LHK
CAMBRIA (APA-36)	W2SLC
CANBERRA (CAG-2)	W3UFM
CANISTEO (AO-99)	K9KBI
CAPRICORNUS (AKA-57)	WB2RAF
CARP (SS-338)	K1UIH
CARPENTER (DD-825)	K4PCF
CARTER HALL (LSD-3)	WB6EHP
CASA GRANDE (LSD-13)	K4JGR
CASCADE (AD-16)	W9OVD, KØTNJ
CATAMOUNT (LSD-17)	K8DEY
CAVALLA (AG(SS)-244)	KØZMQ
CHARLES P CECIL (DD-835)	K8ZHA
CHEMUNG (AO-3Ø)	WA5IXB
CHESTERFIELD COUNTY (LST-551)	K6RGO
CHICAGO (CG-11)	WA4GMF, K1YCD, K7GBN, WA8CMW
CHIKASKIA (AO-54)	W3IAM
CHIPOLA (AO-63)	K5DIO, KH6EJR, K5FMD, KØOAQ
CHIVO (SS-341)	W4VID
CHURCHILL COUNTY (LST-583)	KZ5LB
GEORGE CLYMER (APA-27)	WA7CZV, K8CRM
COATES (DE-685)	W1IFO
COCHRANE (DDG-21)	K6GIW
COCOPA (ATF-1Ø1)	W6AAG
COGSWELL (DD-651)	KL7EUQ, K7WYC
COLONIAL (LSD-18)	WA6UJV, W4ZEH
COLUMBUS (CG-12)	K5BWV
COMPAS ISLAND (EAG-153)	WB2BTN
CONE (DD-866)	K5HWH, WA2VCQ
CONSTELLATION (CVA-64)	WB6BVQ, WA6SXV, W6CKO, WB4CJJ, K7LWY, W4NNC
CONYNGHAM (DDG-64)	WB2OCK
COONTZ (DLG-9)	KH6EEL
CORAL SEA (CVA-43)	W9FGD, WA6ONO
CORRY (DD-817)	K3GLX
COURTNEY (DE-1Ø21)	WA2IQX
CROMWELL (DE-1Ø14)	K6HAS
ALFRED A CUNNINGHAM (DD-752)	WA2HZT, K5ECA
CUTLAS (SS-478)	W2BAG
DAHLGREN (DLG-12)	K8DMS, WA4LIG, KØOID, WA5CXH
JOSEPHUS DANIELS (DLG-27)	WB6HWZ
DARBY (DE-218)	W3BIV, K3BVE
DASH (MSO-428)	WA2ELV
DAVIS (DD-937)	WA1DAJ
DENEBOLA (AF-56)	K9ZLE
DEWEY (DLG-14)	W8CVJ, WA2TPQ, WA4VAI, K8EVS, K3CJG
HARLAN R DICKSON (DD-7Ø8)	W1HHB
DIRECT (MSO-43Ø)	WA4KJB
DULUTH (LPH-6)	K7VSA, WA6NJS, WB6RTT, WAØBDI
DUPONT (DD-941)	K2LUU, K4PSE
DUXBURY BAY (AVP-38)	K3TUV
DYESS (DD-88Ø)	WA1FKI
GEORGE EASTMAN (YAG-39)	K4SBF

The first nuclear-powered guided-missile frigate, the *U.S. Bainbridge*. The ham shack on board uses navy communications equipment—Radioman Charles Davis WA8BPY, Radioman Donald Atkins K5KLE and Lt. Paul Johnson KØJWX are operators.



Official U.S. Navy photograph.

EATON (DD-51Ø)	K4IOV
EDISTO (AGB-2)	K1UFU
ELDORADO (AGC-11)	K4AFS
ELOKOMIN (AO-55)	WA3BXQ
EMBATTLE (MSO-434)	KØKKW
ENDURANCE (MSO-435)	K6ZQB
ENGAGE (MSO-433)	WA6IQW
ENGLAND (DLG-22)	WB6QPY
ENHANCE (MSO-437)	WA4RKM
ENTERPRISE (CVA(N)-65)	W7WFJ
EPPERSON (DD-719)	K9WZL, KØFJX
ESSEX (CVS-9)	W2IRI
ESTES (AGC-12)	K2GIG
EVERGLADES (AD-34)	K4TFE
EVERSOLE (DD-789)	K9TQE
EXPLOIT (MSO-44Ø)	K1YPG
FARRAGUT (DLG-6)	K1KK
FORRESTALL (CVA-59)	WA4UVR
FORSTER (DER-334)	K6QWZ
FORT MANDAN (LSD-21)	KØRYJ
FORT SNELLING (LSD-3Ø)	WA1BSH
DOUGLAS H FOX (DD-779)	W4ATT
MYLES C FOX (DDR-829)	K1CTD
FREMONT (APA-44)	W9PJK
FRIGATE BIRD (MSC-191)	WA4OQB
FRONTIER (AD-25)	WB6QLG, WB6ONN
FULTON (AS-11)	K9HAI, WA1CME
GAINARD (DD-7Ø6)	K1WHO
GALVESTON (CLG-3)	WB6DCG
GARCIA (DE-1Ø4Ø)	WA2DLT, W7HUO, W5BMS
THOMAS J GARY (DER-326)	WA1FETN, WA1FRG, WA5OSR
GEARING (DD-71Ø)	WA1BJH
GENESEE (AOG-8)	K5HKK, K6LHC
HOWARD W GILMORE (AS-16)	W4CSE
GLACIER (AGB-4)	WA6QFT
GRAMPUS (SS-523)	WA4UMA
GRAND CANYON (AD-28)	K8ZPS
EUGENE A GREENE (DD-711)	WA4HIX
GREENWICH BAY (AVP-41)	WA4DRR
GREENWOOD (DE-679)	W4KLB
GRIDLEY (DLG-21)	WA7MEC
GUAM (LPH-9)	WØGVH, K3KMS
GUNSTON-HALL (LSD-5)	W7IIZ
GURKE (DD-783)	K4UOM
GYATT (DD-712)	K4BJM
HALFBEAK (SS-352)	K1OKZ
HAMMER (DD-718)	KØDNP, WB6NZF
HANSON (DD-832)	W9BJT
HARTLEY (DE-1Ø29)	WA1DAI
HARWOOD (DD-861)	W1AFG
HASSAYAMPA (AO-145)	K8WOW
HAWKINS (DD-873)	KP4BPG
HAYNSWORTH (DD-7ØØ)	WA5AXW
HAZELWOOD (DD-531)	K8PXG
HENRICO (APA-45)	WB6GMC
HERMITAGE (LSD-34)	WB2HTG
HISSEM (DER-4ØØ)	K6OBM
HOEL (DDG-13)	WB6RHO, WØRDP
HOPEWELL (DD-681)	WA5BDR
HORNET (CVS-12)	WA4EXJ, K4OCG, K6UPL, W4OUO, WB6RKM, WB6RCV, WA8NMT, WA5NRT, WA9QOJ
HULL (DD-945)	K6HXV
HUNLEY (AS-31)	W6HOM
ROBERT K HUNTINGTON (DD-781)	K9WQK
HUSE (DE-145)	W5LSD
HYMAN (DD-732)	K8JIO
INDEPENDENCE (CVA-62)	WØFPA, K4RSH
INGRAHAM (DD-694)	W8VRR
INTERPRETER (AGR-14)	K3YDV
INTREPID (CVS-11)	K9JXV, K4YXK, WA4TTN, WA5ENI, K5GXR, K4MFL, K7PPW, K1YYJ
ISLE ROYALE (AD-29)	K1FFC
IWO JIMA (LPH-2)	W6BQM, K4PWE
JACK (SS(N)-6Ø5)	W9FMO, K3SHA, W5DBC
JEROME COUNTY (LST-848)	KH6EPA
DANIEL A JOY (DE-585)	K8BBT, WØTZK
KANKAKEE (AO-39)	WA1CRY, WA5BNH
KASKASKIA (AO-27)	K3MTP, K4CCK
KEARSARGE (CVS-22)	WA6KGG, W5ARZ, W6AJY, WAØNPY, WA6RIH, WB6CIK, K7ROP
WILLARD KEITH (DD-775)	K4QDL
KENNEBEC (AO-36)	WA4LWB
JOHN KING (DDG-3)	K3UKE, WA8QBN, WA4GTA
KITTY HAWK (CVA-63)	WA4OIV
KOINER (DER-331)	WØLHG, K3ZZM
KRETCHMER DER-329)	W4ZBF
JAMES E KYES (DD-787)	K9BMH
LAFFEY (DD-724)	WA8CND
LAKE CHAMPLAIN (CVS-39)	KØDUG
EVERETT F LARSON (DD-83Ø)	K6PKD
LASALLE (LPD-3)	WA5HUR, K3OZD, KØBPH
LAWRENCE (DDG-4)	K9ZMZ
LEAHY (DLG-16)	W1UNV, WA4YAE
WILLIS A LEE (DL-4)	K9JWV
LEXINGTON (CVS-16)	K9IOD, K1GKM
WALLACE L LIND (DD-7Ø3)	WA4SZI
LINDENWALD (LSD-6)	W5HNE
LITTLE ROCK (CLG-4)	K4JOH
LOESER (DE-68Ø)	K8QMJ
LONG BEACH (DG(N)-9)	WB6AKN
LOWRY (DD-77Ø)	K9PAE
LOYALTY (MSO-457)	K4KOI
ROBERT H MC CARD (DD-822)	WA4MQZ
MC CLOY (DE-1Ø39)	K1UGW, W1RHO
LYNDE MC CORMICK (DDG-8)	K9TMH, WA6DDM
EDWARD MC CONNEL (DE-1Ø43)	WA4UFD
MC MORRIS (DE-1Ø36)	K6MUX
MAC CONOUGH (DLG-8)	KØMOC
MAHAN (DLG-11)	KØVVR, WA4DWD, W5DJQ
MANLEY (DD-94Ø)	WAØFUU, WA5AXW
MARIAS (AO-57)	WA9JSF
MARYVILLE (EPCER-857)	WA3BIM, W6DLJ
MASSEY (DD-778)	K2PQV
MAZAMA (AE-9)	W4IKS, K4NTC
MEREDITH (DD-89Ø)	K4HID
MIDDLESEX COUNTY (LST-983)	WA9PWI
MIDWAY (CVA-41)	K8NJU, WB6GGD, K5TLM, KØPHX, K1OTI
MILLS (DER-383)	WQ2WAI
GENERAL WILLIAM MITCHELL (T-AP-114)	WA5JLU, WA5CHJ
MITSCHER (DL-2)	W9MI

MOALE (DD-693) WB2NFW
MOCTOBI (ATF-105) W4UAF
MONTROVIA (APA-31) KØHRE
MONTICELLO (LSD-35) W1CUS, K6MAV
MOUNT MC KINLEY (AGC-7) W6DDT, WB6DJW
MOUNTRAIL (APA-213) W8EOP
MUNSEE (ATF-107) KH6EEL
NAVARRO (APA-215) W5GKV, W7RIL, WA8KAB
NEW (DD-818) K3UKZ
NEWPORT NEWS (CA-148) W1UNC, WA4MBE, K4VIV
NICHOLAS (DD-449) K5WFQ
NIBLE (MSO-459) WA5CXH
NITRO (AR-23) WA8APC
NOA (DD-841) K2QNG
NORFOLK (DL-1) WA4EQD
NORRIS (DD-859) K1DRB
OAK HILL (LSD-7) K7TXZ
O'BANNON (DD-450) KH6FQL
OBSERVATION ISLAND (EAG-154) K1TTN, W4JLE
O'HARE (DD-889) W4UAJ
OKANOGAN (APA-220) K4NEL, K1YUK
ORION (AS-18) K5BZZ
ORLECK (DD-886) K9BFK
ROBERT A OWENS (DD-827) K8UML
PAGE COUNTY (LST-1076) WA4YBN
THADDEUS PARKER (DE-369) WA5HBF
FLOYD B PARKS (DD-884) W9UQP, K6ZIC, WØQDJ
PARROT (MSC-197) WA5CXH
PARSONS (DD-949) WB6ASO
PEREGRINE (AG-176) K9LMG
NEWMAN K PERRY (DDR-883) WA2FVT, WA8NLL
PICKET (AGR-7) K7VGW
PINE ISLAND (AV-12) K7YSU
PIPER (SS-409) K1BHV, K1TFX
PLUCK (MSO-464) WA6WLJ
PLYMOUTH ROCK (LSD-29) K2PIQ
POCONO (AGC-16) WA4SPF
POINT DEFIANCE (LSD-31) WA6LMK
POWER (DD-839) WA8GHQ
WILLIAM V PRATT (DLG-13) K9ZQH, WA2SYV
PREBLE (DLG-15) W3VYW
PRINCETON (LPH-5) K3UPN, KA6SRC, K2GIG
PROVIDENCE (CLG-6) W6ACH
CASIMIR PULASKI (SSB(N)-633) K9CJL, WA5DLS
PURDY (DD-734) K1WTI, W6EYI, K1NQH, K1NWD, WA3DMA
PRYO (AE-24) K5BSG
QUILLBACK (SS-424) W4FTL
RALEIGH (LPD-1) K1VJC, WN4UOT
RANDOLPH (CVS-15) K2JSR
RANGER (CVA-61) W4IAN, K1RNL
SAM RAYBURN (SSBN-635) WA1BSE, K1PDL, K8QLW
RECLAIMER (ARS-42) W5GOG
REDFIN (AS(SS)-272) K3IPX
RENVILLE (APA-227) WN8CKR
REPOSE (AH-16) WA6YHD, KH6EJR
PAUL REVERE (APA-248) WA6KGZ
REXBURG (SPCER-855) K5HKO
RIVAL (SMO-468) W4VFV
CHARLES H ROAN (DD-853) WA6VRR
ROBERTS (DE-749) W3ZNK
SAMUEL B ROBERTS (DD-823) K9MLK
ROCKBRIDGE (APA-228) WB2UWV
ROCKVILLE (EPCER-851) W7FNP
FRANKLIN D ROOSEVELT (CVA-42) WA9AJW, W6GTJ, K8NYP
ROWAN (DD-782) K7BBI
FORREST B ROYAL (DD-872) WA9OXU, K7DTS
WILLIAM R RUSH (DD-714) K1JUV
SAILFISH (SS-572) K1FPP
SAINT PAUL (CA-73) K7IEY
SALAMONIE (AO-26) W3YVJ
SALINAN (ATF-161) WAØKZL
SAMPSON (DDG-10) W3KUA
SAN MARCOS (LSD-25) W4LNQ, W1NHK
SAN PABLO (AGS-30) K4FUJ
SARATOGA (CVA-60) K2UVG
SARSFIELD (DD-837) K3JLN
SAVAGE (DER-386) WA4PCA
SEA LEOPARD (SS-483) K3OVE
SEAN LION (AP(SS)-315) WA4BDO, WA4OZG
SEA POACHER (SS-406) K4YRE
SEARCHER (AGR-4) W1LWD, WA1BQH, WA4SSC
SEA ROBIN (SS-497) K3QBP
SELLERS (DDG-11) WA8JZN, K8SXB
SEMINOLE (AKA-104) W4PIO
SEMMES (DDG-18) WA4VAK, WA5OSA, WA4TOV
SENECA (ATF-91) K9CDQ
SEVERN (AO-61) WA6NKQ
SHAKORI (ATF-162) W2ABZ
SHELTON (DD-790) WB6QYF
FORREST SHERMAN (DD-931) K8NSR, W8VRR
SHRIKE (MSC-201) K3SWB
SIERRA (AD-18) K4NOO, W4YJC, K5PDQ
SIRAGO (SS-485) WA4QOZ
SKYLARK (ASR-20) K9HAI, KH6EYC
SOUTHERLAND (DD-743) WB6BQE, K6VMV
SPRINGFIELD (CLG-7) WA5BXF
STARK COUNTY (LST-1134) KH6FCB, WA5NNO
STATEN ISLAND (AGB-5) WB6NEO, WA4FJI, KL7EAL
STEINAKER (DD-863) WA7BOD, K3FXT, K1LQA
HENRY L STIMSON (SSBN-655) W1IOW, WA1BMT, W7RPK, W1VRT
STODDARD (DD-566) K7LNQ
BENJAMIN STODDERT (DDG-22) WA6NWZ
STORMES (DD-780) K4HBT
STRIBLING (DD-867) K5VBO
STRONG (DD-758) WA2NVD, K8KXT
SUFFOLK COUNTY (LST-1173) WAØADO
SUMMIT COUNTY (LST-1146) WA9NLC
ALLEN M SUMNER (DD-692) W5CPQ
SUMNER COUNTY (LST-1148) WA6QVW
SWERVE (MSO-495) WA4FZP
TALBOT COUNTY (LST-1153) W4JZN
TALLAHATCHIE COUNTY (AVB-2) K3YVJ
TALUGA (AO-62) K8QJF
TANNER (AGS-15) W2MNK, W2HLI, W1FKA
JOSEPH K TAUSSIG (DE-1030) K9QBC
TAWAKONI (ATF-114) KH6FJE
TELFAIR (APA-210) K4UGT

TERREBONNE PARISH (LST-1156)	WA5LWJ
LLOYD THOMAS (DD-764)	W1LWD
JOHN W THOMASON (DD-76Ø)	WB6OKO
THOR (ARC-4)	K4JOH
TICONDEROGA (CVA-14)	W4PAE
TIDEWATER (AD-31)	K5BZF
TILLS (DE-748)	W1GPY
TIOGA COUNTRY (LST-1158)	K5ARW
TOPEKA (CLG-8)	K6QXX, K9EPT, W4MCH
TORSK (SS-423)	KØGWG
TORTUGA (LSD-26)	K7ZWU
TOWHEE (AGS-28)	K4ZED
TRIGGER (SS-564)	W2CIR
TRUTTA (SS-421)	K4CJP
TULLIBEE (SS(N)-597)	W1VRT
TUTUILA (AGR-4)	K3QNP
UHLMANN (DD-687)	W6VOQ, K8MBN
UNION (AKA-1Ø6)	WA6SZS
UTINA (ATF-163)	K9JLX
VALLEY FORGE (LPH-8)	K1GUD
VANCE (DER-387)	WA4HTF
VAN VOORHIS (DE-1Ø28)	KØVRF
VEGA (AG-59)	WØQMY
VERMILLION (AKA-1Ø7)	K2QJR, K8TJZ
VERSOLE (DD-878)	W1CHQ, WA4SSC
VERSUVIUS (AE-15)	WA6RDH
VIGIL (AGR-12)	W8ZRY, W9PDW
VIGOR (MSO-473)	WA5IAG
VOGELGESANG (DD-862)	K5UCE, W4UAJ
WAHKIAKUM COUNTY (LST-1162)	K3KFE
WALDO COUNTY (LST-1163)	K4HCD
WALDRON (DD-699)	K8UHX, K1TLQ
WALTON (DE-361)	W6SAW
CHARLES R WARE (DD-865)	K5MCM
WARRINGTON (DD-843)	WA4VEL
WASP (CVS-18)	K3QEQ, K2VVO, WA4MYJ, K2CBF
WHETSTONE (LSD-27)	W4FLF
WHITEHURST (DE-634)	W7WWIN, K6QXR
WILKINSON (DL-5)	K1JQM
JOHN WILLIS (DE-1Ø27)	WA1CNC, WA3EAI
WINSTON (AKA-94)	W5CAT
WILLIAM M WOOD (DD-715)	K1RNA
WOOD COUNTY (LST-1178)	W4RRO
WRANGELL (AE-12)	WA2ASM
YANCEY (AKA-93)	WA4RRO
HARRY E YARNELL (DLG-17)	WB2DXR, WA2PTQ
YELLOWSTONE (AD-27)	K1WGO
YORK COUNTY (LST-1175)	WA4QZG
YORKTOWN (CVS-1Ø)	W8NBO, WA4OKF, WA6PPX
YOSEMITE (AD-19)	K1HVJ
ZELLARS (DD-777)	K4FPH

MISCELLANEOUS

CAMCARDIV 16	W4HME
COMCRUDESFLOT 6	W4IJQ
COMDESDIV 42	K5CXR
COMDESDIV 112	WØDRO
COMDESDIV 222	W4TGB
COMDESDIV 322	W4UAJ
COMCRUDESLANT	K4CEC
COMDESRON 4	WA4JIZ
COMDESRON 6	WA4OMK
COMDESRON 17	K9PUI
COMDESRON 32	WA4RRO, W1UNC
COMIDEASTFOR	K3TUV
COMINDIV 73	WN6OIU
COMPHIBGRU 4	K4BLS, W4BNT

USNS

GENERAL H H ARNOLD (T-AGM-9)	KA4EBR, K4CQD, W5CCA, W2ISJ, WA4PQD, W3WBM, K4TXE
BALD EAGLE (T-AF-5Ø)	WB4AOT
BARRETT (T-AP-196)	W6WCM
GENERAL R M BLATCHFORD (T-AP-163)	WA6IEV
COASTAL CRUSADER (T-AGM-16)	W3HSW
COASTAL SENTRY (T-AGM-15)	WA4OUE, WA4EGJ, W1BZO
CORPUS CHRISTI BAY (T-ARVH-1)	WA9ENW, K4IEG, WØEBN, WA5DNO
CROATAN (T-AKV-43)	W1JSX
ELTANIN (T-AK-27Ø)	W1YMG
FURMAN (T-AK-28Ø)	K7SEW
GENERAL HUGH J GAFFEY (T-AP-121)	KB6BU, K6PJF
JOSIAH W GIBBS (T-AGOR-1)	W4DAY
GENERAL W H GORDON (T-AP-117)	WB6PKN, W6GIB
GREENVILLE VICTORY (T-AK-237)	W2HMW
HARRIS COUNTY (T-LST-822)	WA6KNA
HUNTSVILLE (T-AGM-7)	WB6BFE, WB6BJF
SGT TRUMAN KIMBRO (T-AK-254)	K6QMS
KINGSPORT (T-AG-164)	K9OLL
KULA GULF (T-AKV-8)	W2YCF
LONGVIEW (T-AGM-3)	KH6CB
MAUMEE (T-PO-149)	K6BPE
MICHELSON (T-AGS-23)	K9PCS
MISSION BUENAVENTURA (T-AO-111)	W3HXE
MISSION SANTA YNEZ (T-AO-134)	WA5FJN
NORWALK (T-AK-279)	W3JAK
PIONEER VALLEY (T-AG-14Ø)	W4CPL
RANGE TRACKER (T-AGM-1)	WA6MAI, WA6WFL, W6YHR
SAMPAN HITCH (T-AGM-18)	WB6NEP, KH6FOS, WB6HTP
TWIN FALLS (T-AGM-11)	W2IEV
GENERAL HOYT S VANDENBURG (T-AGM-1Ø)	W3HSW, WA4SUM, W4JIV, WA2BTB, K2JMI
WHEELING (T-AGM-8)	WA6MCP, K5COU, KØDNM
WYANDOT (T-AKA-92)	K2SFE
YUKON (T-AO-152)	W6JJY

AERONAUTICAL MOBILE

AIRDEVRON 1	WB6MBU
ALUSNA, ATHENS	WA6HSH
NAS MINNEAPOLIS	KØNAG
NAS OCEANA	W3ZOT
PATRON NINE	WB6NXN, WØLHN

Fire in the Hamshack-Are You Ready?

Are you prepared in case of a fire in your hamshack? Have you made any plans for the event? How much protection do you have? Does your insurance cover your equipment in case of fire? These are some questions which should be considered by any serious amateur.

Fire prevention costs very little except for time, planning and workmanship. Everyone knows about fuses, circuit breakers, ash trays, chassis and cabinet-ground straps and a good ground system. How many of us ignore or abuse the limits of this protection? There should be a master switch which will kill all of the power in the shack, except for the lights. This is good protection. A good type of fire extinguisher should be on hand in a prominent place, preferably near the door. Having it under the workbench, or over there behind something when you need it is as bad as not having one at all. There are several types of fire extinguishers on the market and most of them are quite inexpensive when compared to the cost of a receiver or a transmitter.

The CO_2 type are best for electrical fires. They smother the fire as well as cool things off. They are fitted with a trigger so they can be used in spurts and can be controlled easily. The CO_2 can be forced into the ventilation holes in cabinets to smother the fire inside, saving time and equipment. The CO_2 type will not damage equipment by corrosion or residue, and is non-conductive so it can be used with safety in high voltage areas. The charge can be checked with a scale, as the full and empty weight are marked on the cylinder. They can be recharged at the central fire station in most large cities.

Another type of fire extinguisher which is very good is the dry-chemical type. It uses a finely powdered dry chemical under pressure to smother the fire. The powder is also nonconductive and non-corrosive. The action is very similar to the CO_2 type. Some of the dry-chemical extinguishers have a gauge which shows the charge, and some can be recharged easily at home. The cost of this type ranges from four to fifteen dollars. For those who feel that this is expensive, a bucket of dry sand will work well in most cases, but it cannot be forced into the cabinets to get at the base of the fire as well as the pressure and nozzle of the extinguisher.

The types of extinguishers which should be avoided are the sodawater-acid and the carbon tetrachloride types. These are very dangerous to use on electrical fires. The soda-water-acid type is conductive, as well as being corrosive to skin, paint, and metal. Picture in your mind spraying a fire in a high-voltage plate supply with a conductive stream which leads to a metal can that you are holding! Now ground your feet in a conductive puddle of the drip and splash! This is worse than shaving in the bathtub with a razor that is plugged into 220 V. Even with the power off, the filters can hold a lethal dose for quite awhile.

The carbon-tetrachloride unit is not as conductive as the soda-acid type, but the carbon tet will break down with heat and the fumes are toxic. Also, the cold stream of carbon tet can break the glass envelopes on any hot tubes which might have been saved by using other types of extinguishers. Current flow through carbon tet will make a very toxic gas. The carbon tet can cause a reaction with some types of plastic, and may cause further damage.

No hamshack should be without a fire extinguisher. Your local fire department will be glad to help you with your choice and location, and will also assist you with its use and storage. The firemen will be only too happy to come to a club meeting and give a demonstration of the various types of fire extinguishers and their uses.

Fire extinguishers are like spare tires; something you hope you will not have to use but a real life saver when you really need them.

. . . K4SEL/DL5AF

Paul Franson WA1CCH

Diode Circuits Handbook

Back in the days, long ago, when diodes were plugged into sockets and required lots of space and heater power, they weren't very common. I guess that they seemed too expensive and wasteful of space to be popular. Rectifiers and detectors were about the only diodes you saw—and the detectors were usually combined with other tubes in common envelopes.

Things are different now. Even those who still build receivers with tubes use lots of diodes. But they're different diodes. Now they're usually tiny glass or plastic-cased silicon or germanium diodes which are soldered into equipment. And they're all over the place. The tube-type "Junior Miser's Dream" in the 1966 *ARRL Handbook* uses ten semiconductor diodes. The Davco DR-30 contains 15 and its power supply uses a few more. There's a good reason these receivers use so many diodes; diodes are very useful. One diode can often take the place of many other components, including such large, expensive, and cantankerous parts as relays, voltage-regulator tubes and switches.

I've often searched through dozens of references for a particular diode circuit and I suspect that many of you have done the same. I finally decided to try to get together all the practical ham diode circuits I could find and put them in a reference article for me—and all 73 readers. Most of the circuits I found seem to be fairly well known and have appeared in many places, so I haven't tried to give credit.

Take a look at these diode circuits. Chances are that some of them are unfamiliar to you and could be useful in some of your projects. Some of the circuits are complete in themselves; many others are used with other devices.

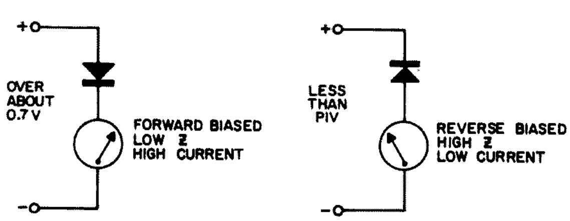


Fig. 1. The properties of a diode depend on whether it is forward biased or reverse biased.

Basic Diode Facts

Uses of readily available, well-known silicon and germanium diodes are the subject of this article. None of the applications are for tunnel diodes, four-layer diodes, or other specialized devices. The varactor circuits I've given will work with at least some common diodes, but work better with varactors, of course. Unless stated otherwise, the diodes shown are not critical.

To use this article, you should keep a few basic characteristics of diodes in mind. What makes a diode a diode is that for a given voltage, it will conduct more current when the voltage is connected across the diode in one way than in the other way. See **Fig. 1.** High current flows (the diode has low resistance) when the positive side of the power supply is connected to the anode of the diode. This is called forward biasing. When a diode is forward-biased, with adequate current flowing through it, it will have a fairly-constant voltage of about 0.7 V across it if it's a silicon diode, or about 0.3 V across it if it's germanium. This voltage is called the forward voltage drop. It will increase slowly with increasing current to a maximum of about 1.5 V for most diodes.

The reverse of forward bias is reverse bias. If you connect a voltage source across a diode so that the positive side of the supply is connected to the cathode of the diode, the diode is said to be reverse biased. A reverse-biased diode acts like a very high resistance so that almost no current flows through it. However, if you increase the voltage to a high enough value, the diode will "break down" and conduct current heavily. If there isn't enough resistance in the circuit to limit the current to a safe

value, the diode will be destroyed. If there is enough limiting resistance, the circuit will settle down with part of the total voltage across the diode and part of the voltage across the limiting resistance. As the voltage is increased further, the voltage across the diode remains fairly constant unless too much current flows and cooks the diode. The break-down point is called the avalanche voltage, for high-voltage diodes, and the zener voltage for low-voltage diodes. The maximum voltage that should be applied to a diode is called its peak inverse voltage (PIV). The PIV, as rated by the manufacturer, is always less than the avalanche or zener voltage.

As you can see from the above discussion, a high breakdown voltage—at least higher than any peak voltages in the circuit—is desirable for diodes used as rectifiers. However, diodes can be used as regulators, too; for this use, a low, and known breakdown voltage is needed. Thus, you can use a zener diode as a rectifier, or a rectifier as a zener, if you are able to pick the right diode.

Silicon diodes resist high temperature better than germanium ones, so are most useful for high power. On the other hand, germanium diodes have lower forward voltage drops (about ¼ V as against about ¾ V for silicon). Silicon diodes usually have lower leakage and higher reverse-biased resistances than germanium diodes.

Diodes have capacitance as well as resistance. This capacitance varies with the voltage applied. A reverse-biased diode is often used as a voltage-variable capacitor (varicap or varactor). Most silicon diodes can be used in this way, but diodes made and tested for this purpose are generally more predictable and satisfactory.

Power Supplies

Rectifiers

Say diode to the average ham, and he thinks of power-supply rectifiers. Diodes, and particularly silicon diodes, have so many overwhelming advantages over thermionic rectifiers that only the most conservative ham, or the ham with a junk box full of 5U4's, still uses tubes. Silicon diodes are cheaper, smaller, more versatile, etc., than tubes. However, semiconductor diodes are far more sensitive to voltage and current

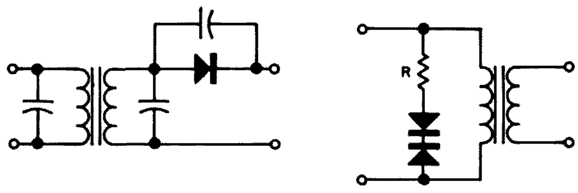
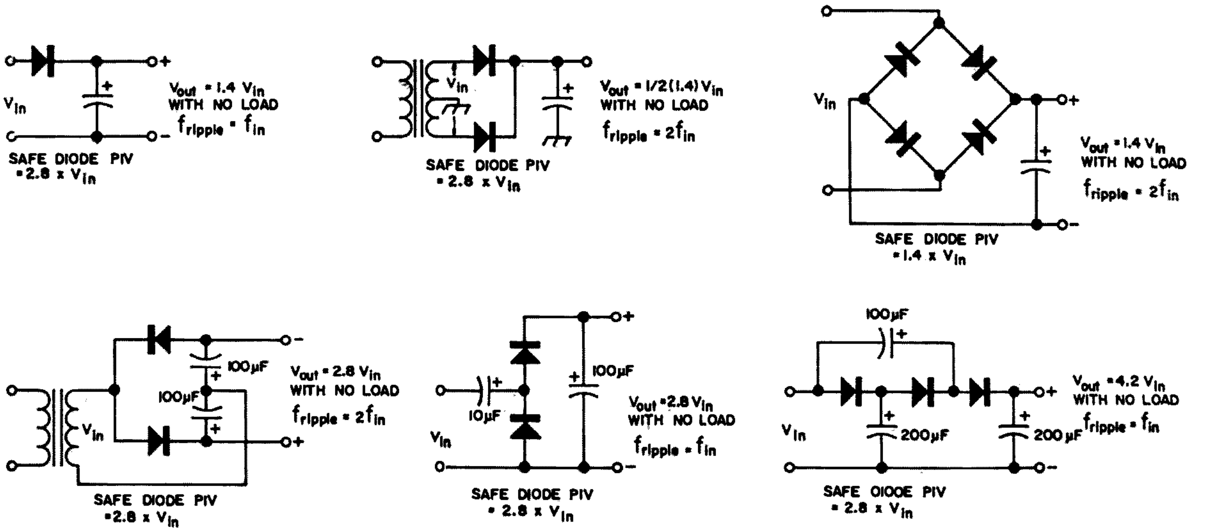


Fig. 2. Capacitors or diodes can be used to reduce transient peaks.

overloads than tubes. The very short transients generated on almost all ac power lines by lightning and large inductors, can ruin unprotected diodes instantly. However, there are ways to avoid such problems. One is to connect small capacitors across the ac line, across transformer secondaries, or across the diodes themselves. These capacitors tend to stretch the length of the voltage pulses while reducing their height. Special semiconductors can be connected across transformer primaries to clip off high peaks, or you can even connect two diodes, cathode-to-cathode, across the primary for the same effect. It's best to choose two diodes with roughly matched avalanche points a little higher than the peak value of the line. The peak value of the 117 V ac line is 170 V, so use 200-300 PIV diodes. See Fig. 2.

Another way to avoid blowing out diodes through accidental voltage transients (which may reach 4-5 kV), is to use special diodes designed to withstand such peaks. They're called controlled-avalanche diodes and in most cases cost more than regular diodes.

Of course, these suggestions can help take care of random voltage transients. But most hams who blow diodes, do it because they haven't been following good "engineering" practice. There's a lot of confusion about the ratings of diodes. The peak inverse voltage, or peak reverse voltage, of a diode, as rated by the manufacturer, is below the minimum peak voltage; which will cause the diode to conduct in the reverse direction. This is equivalent to the "zener" break of high voltage diodes. For instance, a diode with a 200-V PIV rating will not conduct current (over a few micro-amperes) for any dc voltage under 200 V applied across it in the *reverse*-biased direction (with the cathode connected to the positive voltage). But, if you increase the voltage over 200 V, at some voltage (its avalanche voltage) the diode suddenly starts conducting like mad, and quickly shorts (for diodes usually



Figs. 3-8. The most popular rectifier circuits with their output voltages and minimum safe diode PIV rating.

short, not open) unless there is enough resistance in the circuit to prevent excessive current flow.

For example, suppose the diode under discussion had an avalanche point of exactly 200 V. If it's a common epoxy-case diode, it can probably dissipate ½ W. That is 2.5 mA, so if more than 2.5 mA is flowing through that diode in the reverse direction, it's not going to stay healthy long. Note that this discussion is about direct current, as it's a little easier to follow than ac. If alternating current is applied across the diode, things are more complicated, but the same basic considerations apply.

If the diode is *forward* biased (positive voltage to the anode), about 0.7 volts will be dropped across the diode. If the diode can dissipate ½ watt, that means (by P=EI) about 700 mA can flow through it.

Manufacturers rate their diodes by minimum PIV's, not actual avalanche voltages (except for regulators). You might do this same thing if you get $10 worth of unmarked diodes from a surplus dealer. You could put out a series of cans labeled 0-100, 100-200, 200-300 and so forth. Then you could check the diodes and throw them in the proper can. Any in the 100-200 PIV can could be used for applications calling for a PIV under 200 V. The ratings on diodes are often conservative. A 1N2069 diode is listed at 200 PIV, so it will have an avalanche voltage of over 200 V, but could be quite a bit higher—I've found IN2069's with avalanche voltages of over 15OO V.

The other diode problem is current overload. There should be enough resistance in the circuit to limit current to the specified peak value, typically 25 A.

Enough theory. **Figs. 3-8** show the most common types of rectifier circuits with the minimum PIV's that should be used for the diodes and the voltage outputs. The voltage "multipliers" (more correctly, "adders") can be carried on to ridiculous limits, but aren't very practical over about four diodes since you start needing so many big charging-filtering capacitors.

When you use discreet diodes in series to get a higher PIV than a single diode has, you should remember that the diodes you use are unlikely to be well matched. They probably have widely different avalanche voltages and back resistances, so that voltages applied across the series string will divide unequally across the diodes. This will likely blow out one of them, which will tend to blow out the others. A simple solution is to connect a 100-kΩ to 1 = MΩ resistor across each diode in the series, as shown in **Fig. 9.** Use the same value across each diode, though the value isn't critical. These equalizing diodes have saved a lot of diodes which otherwise would have blown. Incidentally, very high voltage rectifiers in one can are generally made from a number

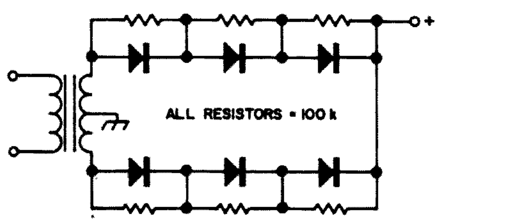
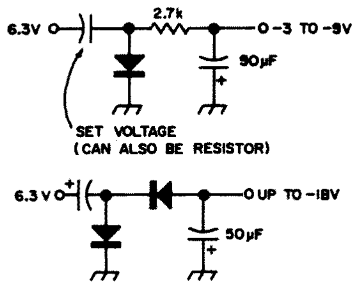


Fig. 9. Resistors are used across series diodes to equalize reverse voltage drop.

of individual junctions in series, but they don't require equalizing resistors since they're made from the same slice of silicon and are well matched.

Most modern transmitters and tube-type receivers require some negative voltage at low current for bias. Probably the easiest way to get this is by rectifying (with multiplying, if necessary) the filament line (See **Figs. 10** and **11**, or by tapping down resistively, or by a capacitor from the high voltage winding of the power supply. For low voltages, common germanium diodes, such as the 1N34, can be used for rectifiers. Shunt rectifiers work as well as series when they're being driven by a high-impedance source, such as a high-value resistor or low-value capacitor. A single diode can put out up to 9 V from a 6 V supply when it's loaded lightly.



Figs. 10 and 11. Simple shunt rectifiers can provide low bias voltages.

Fig. 12 is a simple bridge high voltage supply which can provide two high voltages at once. One voltage is about twice the other. This type of rectifier is often used with a junked TV power transformer for transmitters in the 100-200 watt range.

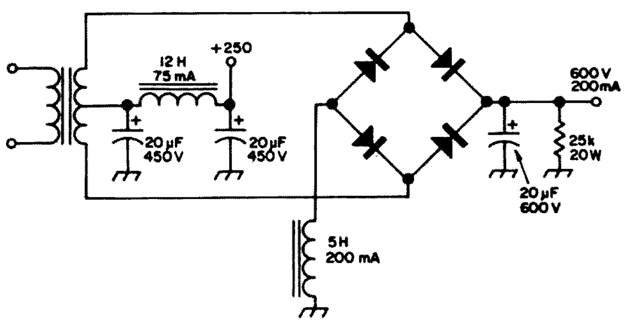


Fig. 12. This circuit gives two outputs, 600 V and 250 V.

Regulators

A zener diode regulator is shown in **Fig. 13**. It doesn't look very impressive, and the values of everything in it are dependent on everything else. W2DXH's 12-page article on zenors in the October 1966 issue of 73, covers the subject thoroughly and succinctly, and there's little reason to go over it again.

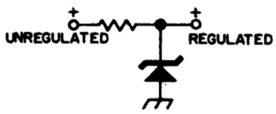


Fig. 13. A basic zener regulator. The values depend on input and output voltage, current, etc.

It's interesting that low-voltage zeners (under about 6 V) and forward-biased silicon diodes (equivalent to 0.7-V regulators) have thermal drifts opposite in direction from the drifts of avalanche diodes (zeners over about 6 V). So we can put one or more forward-biased diodes in series with a regular zener (as in **Fig. 14**) to decrease the total temperature-voltage drift. These diodes are also useful to boost a zener up a little amount. Remember that forward-biased silicon diodes act like 0.7-V regulators, and forward-biased germanium ones act like 0.2-0.3 V regulators.

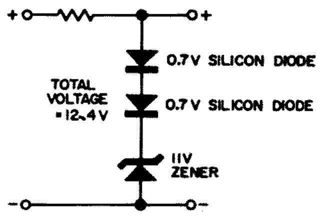


Fig. 14. Forward-biased silicon diodes can be used as low-voltage zeners. Their temperature drift is opposite that of regulators with breakdown voltages over 6 V, which is convenient for temperature stabilization.

An interesting use of a zener is shown in **Fig. 15**. Here the zener is used to increase the voltage rating of a low-voltage capacitor.

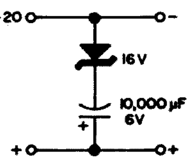


Fig. 15. A zener can be used as a ripple filter and to "increase" the voltage rating of a capacitor.

Fig. 16 shows the use of two different zeners to get a regulated low voltage. You can use a forward-biased diode in a similar manner to get a regulated voltage slightly lower than a given zener will provide. For instance, suppose you have a 10 V zener, but want a slightly lower voltage. A for-

ward-biased silicon diode (the reverse of the one shown) connected in place of the 8 V zener would give about 9.3 V.

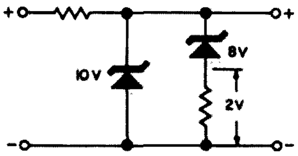


Fig. 16. Two zeners can furnish a regulated low voltage.

Zeners can also be used on ac. **Fig. 17** shows this use to regulate at slightly less than 110 V.

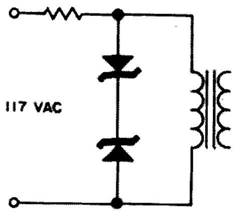


Fig. 17. Zener regulators can be used on ac, too.

Meters

AC meters

Since true ac meter movements are very frequency sensitive, most meters used by hams are dc meters. Diode circuits can be used with dc meters to make ac meters for many different uses. However, this can be tricky and it's a good idea to understand what's happening in the circuits. The most common and useful method for describing an ac voltage is in terms of RMS (root-mean-square), or effective, voltage. This voltage has the same heating effect as a dc voltage of the same value. The 117 we call the ac line is an RMS value. However, most ac meters made from a dc meter and a rectifier, read either peak or average value rather than RMS since these circuits are far simpler. The peak value is the difference between the 0 point of a wave and its highest peak, as measured on an oscilloscope. The average value, which should be called the average rectified value, is of very little use in radio and chances are you've never even seen an average value mentioned except in discussions of ac voltmeters. If you're curious, it's the area under the curve, divided by the time measured. There is a very simple relationship between these values—for perfect sine waves: peak is about 1.4 (or exactly $\sqrt{2}$) times RMS; RMS is about 0.7 (exactly $1/\sqrt{2}$) times peak; average is about 0.6 (exactly $2/\pi$) times peak and so forth. However, for wave shapes other than perfect sine waves, the relations are not the same, and we must give some thought to the measurements we make under these conditions.

Average-reading meter

The most common type of ac voltmeter—the type used in virtually all VOM's, for example, is shown in **Fig. 18**. This circuit usually uses a copper-oxide bridge rectifier since this type of rectifier is linear at much lower levels than silicon or germanium diodes. Notice that there is no capacitor in this circuit. The reading on the meter will be the average value of the ac waveform. However, the scale is almost always calibrated in terms of RMS. As mentioned before, this is accurate only for true sine waves, but is generally satisfactory for other waveforms as even 10% second-harmonic energy causes only 3% error. This type of rectifier circuit is useful up to a few hundred kilohertz. It cannot be used higher because of the properties of the rectifier and the high stray capacitance of the circuit.

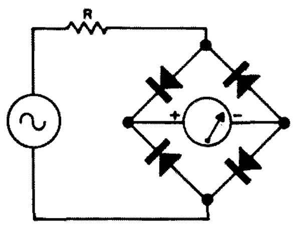


Fig. 18. A bridge average-reading ac meter.

Peak-reading meter

Fig. 19 is very similar to **Fig. 18.** The only apparent difference is the addition of the capacitor C. If C is very large and

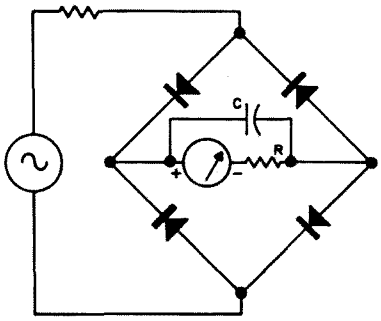


Fig. 19. A bridge peak-(or semi-RMS) reading ac meter.

the meter has a high resistance, the capacitor will stay charged up to a high level and the meter will read approximately the peak value of the waveform. For instance, with a 1-mA meter and 50-μF capacitor, this makes an excellent peak meter for the value of fairly constant audio voltages. The time constant is too long to follow fast changes. This meter is excellent for aligning receivers with a modulated signal generator.

RMS-reading meter

If capacitor C in **Fig. 19** is made small with regard to the period of the ac frequency being measured, the meter will read approximate RMS. Unfortunately, the optimum value for the capacitor will vary with frequency, so this type of meter has limited use. A combination of peak- and average-reading meters can provide a meter which reads closer to RMS.

Peak-to-peak-reading meter

Sometimes we need the peak-to-peak value of an ac voltage. This will be twice the peak value on a symmetrical wave, and it can be measured with the circuit of **Fig. 20** This, of course, is a voltage "doubler." The capacitors must be large, and the meter resistance high, to keep the capacitors charged.

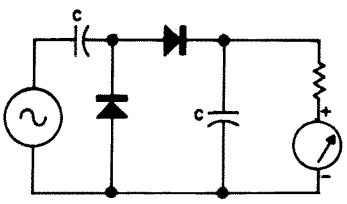


Fig. 20. A peak-to-peak reading ac meter is simply a voltage "doubler."

Variations of basic ac meters

Another type of peak reading voltmeter is shown in **Fig. 21.** It is a half-wave rectifier, unlike the full-wave bridge peak-reading voltmeter shown in **Fig. 19.** This circuit, or a variation of it, is used in rf probes

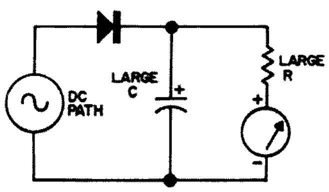


Fig. 21. A half-wave peak-reading ac meter.

where the rectifier must be close to the circuit being measured.

A similar peak reading circuit that requires no dc path is shown in **Fig. 22.** Another type of RMS-reading meter is shown in **Fig. 23.** This one is useful only over a limited frequency range.

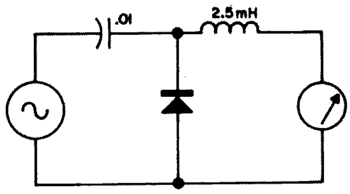


Fig. 22. A half-wave peak-reading ac meter that requires no dc path.

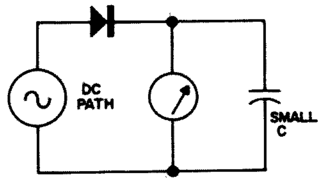


Fig. 23. A semi-RMS-reading ac meter.

Reversable-polarity meter

Fig. 24 looks like an ac voltmeter, but it can also be used for something else. Remember the last time you made a small transmitter and wanted to measure both the grid and plate currents? They are opposite in polarity, so it took a DPDT switch. This circuit gets around that. Voltages of either polarity may be applied to it and will always read upscale.

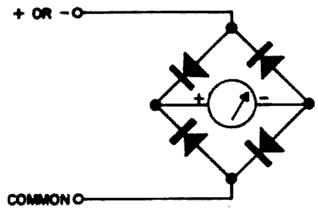


Fig. 24. A meter for ac, or either polarity dc.

Expanded and compressed scales

Zener diodes may be used to play some interesting tricks with dc-reading meters. For instance, suppose you want to meter the voltage in your car. It never goes below 12 V or above 15 V. If you use a 15-V meter, the variation will be a small part of the scale and hard to read. But if we expanded the 12 to 15 V range to fill the face of the meter, the variations would be very noticeable. A way to do this is shown in **Fig. 25.** A 12-V zener diode is placed in series with a 0 to 3 V meter.

The meter reads nothing until the voltage reaches 12 V, then reads normally from 13 to 15 V. This is called supressing the low end of the scale.

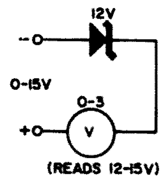


Fig. 25. A zener and a low-voltage meter can be used to suppress the low end of a range.

The last circuit for modifying meters is shown in **Fig. 26.** It partially suppresses the low end of the scale. For example, the meter can be made to read 0-9 V in the first half of the scale and 9-12 V in the second half. Values will depend on the voltages and meter.

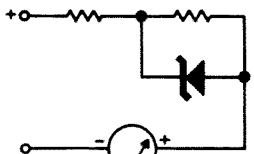


Fig. 26. This circuit partially suppresses the low end of a range.

Meter protection

You can also suppress the high end of the scale. If that sounds rather pointless, you can think of this operation as a meter protector. **Fig. 27** shows the circuit. The resistors will depend on the voltage, etc. If the zener is picked to conduct at the high end of the scale, the meter will not be overloaded even by voltages much higher than should be applied to it.

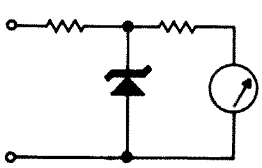


Fig. 27. This is a meter-protective circuit. The zener should be tapped on the resistor chain at a point that provides conduction when the meter pointer is pinned.

Fig. 28 is a simpler meter protector using a run-of-the-mill silicon power diode or two. A silicon diode acts like a 0.7-V zener when it's forward biased, so will conduct whenever the voltage across the meter goes over 0.7 V. It's best to use two diodes back-to-back for maximum protection. Having the meter needle take off in the wrong direction with 0.7 V is better than with 400 V. As an example of the voltages involved, a 50-μA, 4000-ohm meter has 0.2 V across it at full scale, so a 0.7-V silicon diode limits overloads to about 3½ times, which most good meters can handle. Incidentally, it's recommended that you also put a .01-μF capacitor across the meter in parallel with the diode or the meter will be very susceptible to rf.

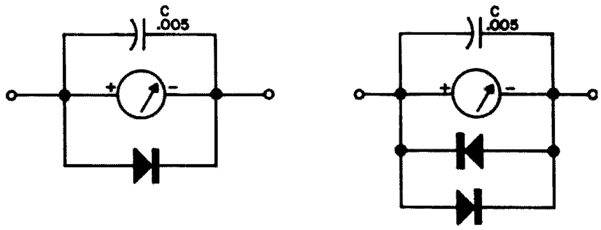


Fig. 28. Conventional silicon diodes can protect a meter movement, too. The 0.005-μF capacitor bypasses rectified rf.

Receiver Circuits

Diode mixer

Diode mixers are rarely used in modern high-frequency or VHF receivers. Transistor mixers give better performance in every respect: gain, noise figure, selectivity, and versatility. However, diode mixers are still used almost universally at frequencies above about 500 MHz, where a diode can provide better results than a transistor—at least at present. A standard type of diode mixer suitable for any frequency is shown in **Fig. 29.** The antenna and local oscillator inputs can be low impedance (as shown) through taps or loops, or high impedance through capacitors connected to the top of the coil. The input coil can be a quarter-wave trough line at UHF frequencies.

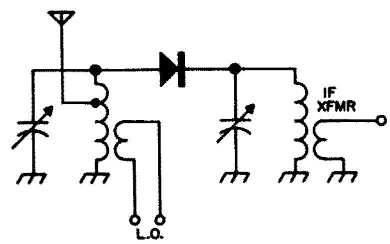


Fig. 29. A basic diode mixer as used at UHF and microwave.

AM detectors

The most popular receiver in the early days of radio was a crystal set. The typical

crystal set used a large coil, a crystal detector, and a set of headphones. The most common crystal detector was a piece of galena (lead sulfide) or some other semiconductor with a springy wire contact (cat's whisker) which had to be adjusted for best results. The modern equivalent of this circuit is shown in **Fig. 30.** It is the half-wave detector used in almost all AM receivers. This detector includes a resonant circuit tuned to the frequency of interest, a diode rectifier and a load. In the diagram, the load is a resistor suitable for transistor *if* use. The capacitor provides filtering and smoothing. The resistor can be replaced by a set of headphones, and a long antenna added to make a modern crystal receiver. A good ground will also be necessary in most places.

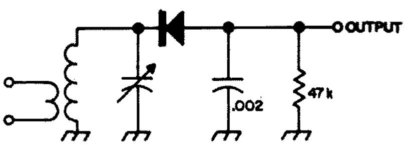


Fig. 30. A half-wave detector. This can be used as a crystal set, too.

The half-wave detector is very popular, but it's far from the best AM detector. The peak-to-peak or voltage-doubler detector in **Fig. 13** provides much higher output with lower distortion and is highly recommended for all AM receiver applications.

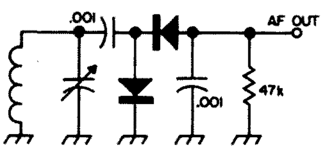


Fig. 31. This detector provides much better results than that in Fig. 30.

Ring modulator

Balanced mixers (or modulators) are becoming very popular in modern receivers as we face the problem of many strong signals in and out of the ham bands. Conventional mixers can easily be overloaded by these signals, while balanced mixers can handle more power and reduce spurious-causing frequencies. The balanced modulators used in SSB generators generally make excellent mixers, but many of them are inconvenient to use in equipment which must be tuned over a wide range. Nevertheless, we will likely be seeing more of them in the future. The balanced modulator shown in **Fig. 32** is a ring modulator which can be used in both receiving and transmitting equipment. The diodes should be matched, as described in the paragraphs in this article on SSB balanced modulators.

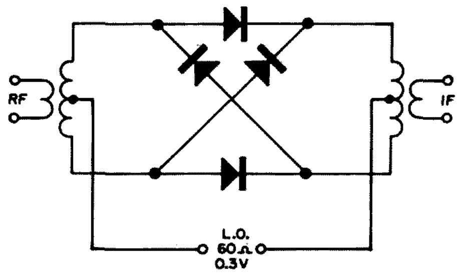


Fig. 32. A diode ring balanced modulator.

Product detectors

While any good AM detector can give excellent results on SSB signals if it has proper BFO injection, a number of circuits have been developed to make tuning and detecting SSB easier. One is the product detector shown in **Fig. 33.** This popular circuit has been used in many ham receivers. The BFO voltage should be 10 to 20 times that of the incoming signal for best results. The diodes should have high back resistance, but must have at least some leakage for the circuit to work properly (or a resistor must be added from the junction of the diodes to ground).

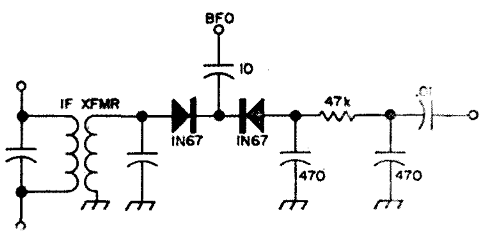


Fig. 33. A popular product detector for SSB.

Another product detector is illustrated in **Fig. 34.** Values are given for use at both 455 kHz and 9 MHz, the most popular SSB *if's*. For use at 2 or 3 MHz, the capacitors and inductors can be about half-way between the values given. Other balanced

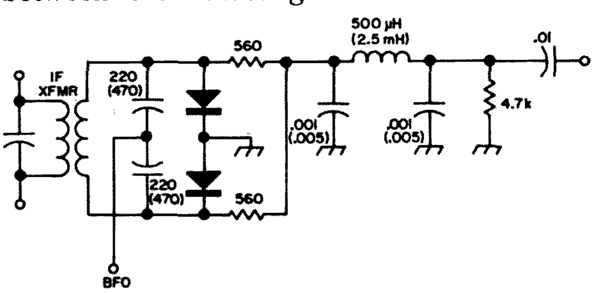


Fig. 34. A product detector for 9-MHz SSB. The values in parentheses are for 455 kHz.

modulator circuits that make excellent SSB detectors are given in the transmitter section of this article.

FM detectors

There are three excellent types of FM detectors using diodes. Two of these are well known to almost everyone in radio. The third isn't, though it's an excellent, inexpensive detector and easy to use. The well-known circuits are the Foster-Seeley discriminator and the ratio detector, shown in **Figs. 35** and **36.** They work on different principles, and the circuits are quite different. The discriminator is easier to align,

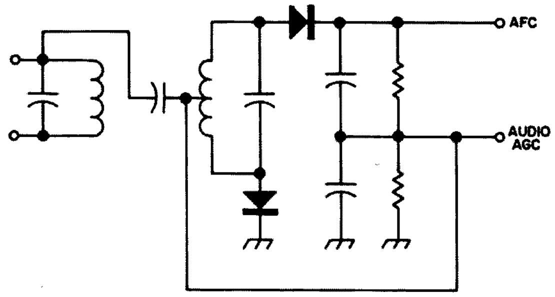


Fig. 35. Foster-Seeley FM discriminator.

but requires a separate limiter to remove AM. This can be a diode limiter or a more popular tube or transistor circuit. Otherwise it is simply a convenient AM *and* FM detector. While that might be useful for many experimental purposes, it is undesirable for most since the greatest advantage of FM is it's suppression of noise and static, which are almost completely AM. The ratio detector is self limiting. When it is adjusted properly, it provides excellent suppression of AM signals. Both of these FM detectors require special transformers.

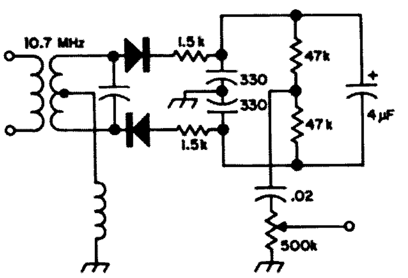


Fig. 36. 10.7-MHz FM ratio detector.

The other, less-common FM detector needs no special transformer; in fact, it needs no transformer at all. It is a pulse-counting frequency meter, as shown in **Fig. 85,** with a filter added to eliminate the carrier components. This is a very versatile circuit. It can be used as a frequency meter, tachometer and FM detector. Unfortunately, the circuit cannot be used very easily at high frequencies (say, over 1 MHz) without a good bit of care. Nevertheless, it is becoming popular and we will probably see it in many FM and TV receivers in the future.

Noise limiters

Most AM communications systems suffer from electrical noise caused by atmospheric disturbances and man-made equipment. Many noise limiters have been developed to try to reduce the effects of this interference. Some noise limiters are effective against only very short, high-impulse noise, while others can reduce more difficult-to-handle, long-term, moderate-level interference. Because of the widely different characteristics of AM, SSB and CW signals, practical limiters are usually designed for optimum results on one type of modulation, and are less effective on others. In all cases, however, noise limiting should be performed before highly selective sections in a receiver, if that is possible. Sharp filters will lengthen noise pulses and make them more difficult to eliminate. The selectivity can also lead to ringing, a very unpleasant sound to human ears.

A very simple noise limiter which can be quite effective against high-impulse, fast pulses in a moderately unselective receiver is shown in **Fig. 37.** The two diodes clip any signals above 0.3 or 0.7 volts (depending on whether the diodes are silicon or germanium). Obviously, the performance of this limiter will be quite dependent on the output impedance and power of the receiver, and the characteristics of the speaker with which it is used. As a rough idea of the levels involved, suppose the diodes are germanium and the impedance is 4Ω (which is not too likely as the impedance of most speakers is very dependent on frequency). By Ohm's Law, $P = E^2R$, $0.3^2 4 = 0.09/4 = 22$ mW. Thus the diodes will start clipping at 22 mW of output. This may well be plenty of audio. If more is desired,

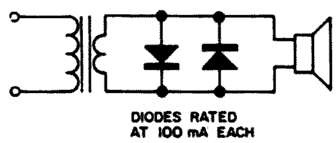


Fig. 37. Shunt diode noise limiter for use across a loudspeaker.

silicon diodes can be used. The volume control must be set for the proper level to clip noise peaks and leave any desired sound alone.

A simple shunt half-wave limiter can be installed at the second detector of the receiver, or at the input to an audio amplifier stage to accomplish much the same thing. Here a single diode may be sufficient because of the characteristics of the detector or the amplifer. **Fig. 38** shows a typical limiter of this type.

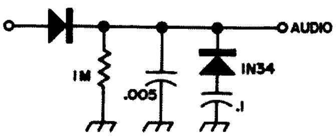


Fig. 38. Shunt diode noise limiter that can be easily added to the input of an audio amplifier.

Fig. 39 illustrates a simple half-wave series peak limiter. It requires a diode with high back resistance; the base-emitter junction of a transistor often makes an excellent diode of this type. This circuit must be adjusted to the proper clipping level for best results. Though there is no negative peak clipping in the circuit, it does a good

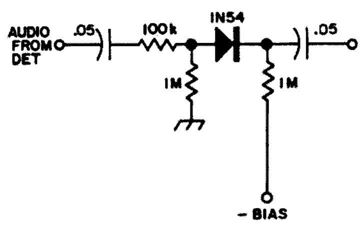


Fig. 39. Half-wave series noise limiter with adjustable clipping level.

job. A better circuit, though, is that in **Fig. 40.** This is a full-wave series peak limiter which clips both negative and positive peaks. This circuit, like the previous one, requires high back resistance diodes for best performance.

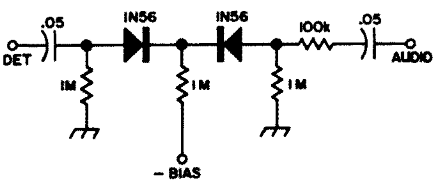


Fig. 40. Full-wave series noise limiter.

An excellent AM noise eliminator is the trough limiter in **Fig. 41.** This circuit will eliminate the background noise that can be very fatiguing, yet it permits most of the audio to pass. This limiter works on the low level signals rather than the high.

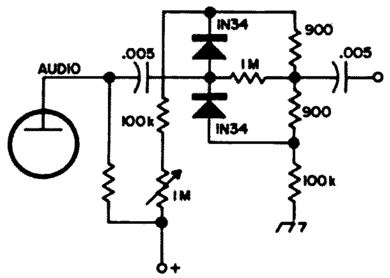


Fig. 41. This "trough" limiter will eliminate the background noise that is ignored by conventional limiters.

Perhaps the ultimate noise limiter for AM use is the rate-of-change noise limiter developed in England for use in the audio portion of TV sets. This detector works on the theory that most noise peaks have a much faster rise time than desirable modulation. The detector eliminates these peaks very effectively, as has been demonstrated by many testimonials. The limiter diode in this circuit, which is shown in **Fig. 42** must have very high back resistance. Transistor junctions have been used for this diode by some hams with excellent results. The detector diode can be any conventional diode. This circuit has some loss, so an extra audio amplifier may be needed in some receivers. The clipping can be adjusted by changing the ratios of the 27kΩ and 18kΩ resistors.

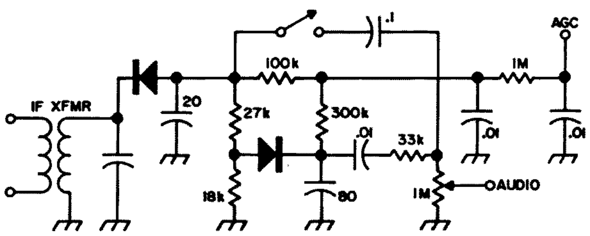


Fig. 42. One of the best noise limiters is the "rate-of-change" limiter designed for TV audio in England.

The next two circuits are installed in the *if* amplifier section of a receiver rather than in the audio section. They provide superior results on SSB and CW, but are not as ef-

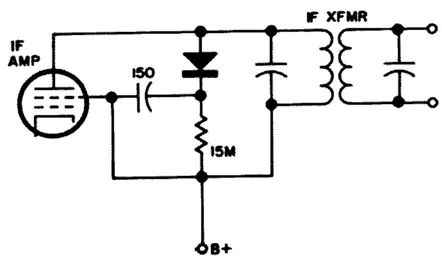


Fig. 43. This simple noise limiter is installed in an *if* stage for SSB and CW use. The diode must have high back resistance, low capacitance and short rise time.

fective as other limiters on AM. The first circuit, shown in **Fig. 43**, uses a fast diode to clip short interference pulses. It is very simple and could be installed in almost any receiver. A slightly more complex circuit is shown in **Fig. 44.** It is self-adjusting. Both of these *if* limiters use fast diodes. Among suitable ones are 1N903, 1N904, 1N916, and MA-4441.

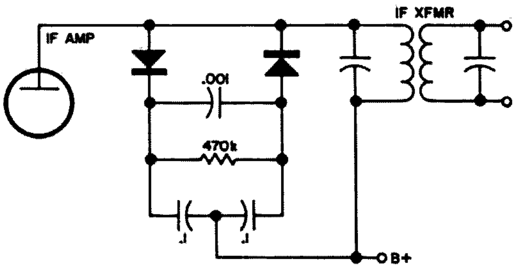


Fig. 44. This is an improved version of the SSB if noise limiter in Fig. 43.

Diode squelch

Diodes make excellent switches. This property can be used in the very simple squelch shown in **Fig. 45.** The diode detector is simply biased to the desired threshhold with the potentiometer and signals weaker than this level will not be passed. There are two major problems with the circuit. It does not quiet the receiver completely, and it introduces distortion on weak signals. However, it is simple, cheap, and easy to add to almost any receiver.

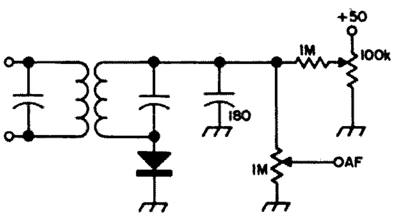


Fig. 45. Simple diode squelch.

Add-on BFO/Q-multiplier

It's very easy to add a simple beat frequency oscillator Q-multiplier to tube-type receivers, and many SWL's and others with receivers not designed for CW or SSB reception should find the circuit shown in **Fig. 46** interesting. The principle is straightforward. If the suppressor grid of a high gain pentode is not connected to ground, the tube will oscillate. We can control the impedance between the suppressor and ground with a diode and make the tube regenerate. This will increase the Q and hence, the selectivity of the amplifier. If the regeneration is carried far enough, the tube will oscillate and can be used for CW or SSB reception. The control potentiometer can be installed on the front panel of a receiver, with the diode and 1.5kΩ resistor near the tube.

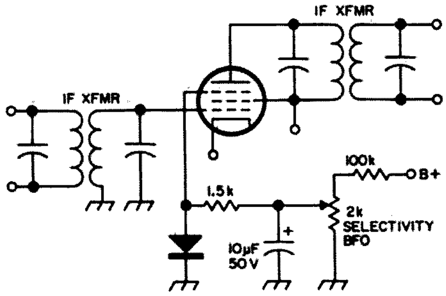


Fig. 46. Adaptor to provide SSB/CW reception and Q-multiplication in a receiver.

Oscillator limiter

It's often difficult to design an oscillator which provides a constant output as its frequency is varied. This is especially true of wide-range transistor oscillators. A circuit designed to stabilize the output of an oscillator of this type is shown in **Fig. 47.** The diode is reverse biased, so it doesn't normally conduct unless the voltage in the tuned circuit exceeds a certain level. Then it conducts on positive half cycles and damps the oscillation. The result is an output which is fairly constant across a band.

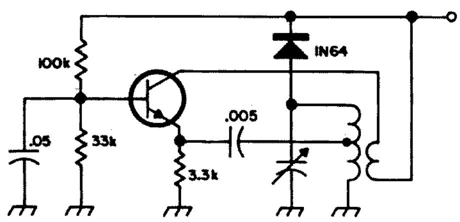


Fig. 47. This circuit uses a diode to limit the output of an oscillator.

Transistor protection

It's always discouraging to burn out transistors, even if they are about the cheapest components used in many projects. An rf amplifier, particularly a low-noise VHF one, is usually tightly coupled to an antenna for minimum noise figure and maximum power gain. Unfortunately, this tight coupling increases the chance that the transistor will be damaged by strong nearby transmitters which may inject too much voltage into the base of the transistor. A simple, effective way to reduce the likelihood that this will happen is to place two low-capacitance silicon diodes across the input coil of the

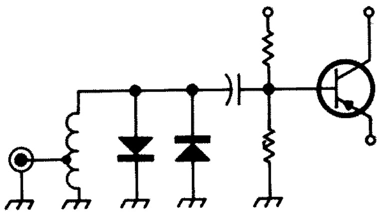


Fig. 48. Diodes can be used to protect a transistor rf amplifier from burnout.

amplifier (**Fig. 48**).These diodes will conduct if the voltage across the coil exceeds about 0.7 V, simultaneously shunting it through the diodes and causing the capacitance of the diodes to change drastically, which will detune the resonant circuit. This will often save the transistor. This pair of diodes will not cause too much signal loss as long as the diodes are suitable for the use. The easiest way to check them is to try the circuit with and without the diodes. Signal strength should be the same.

Automatic gain control

A circuit designed to adjust the amplification of a receiver for approximately constant output with varying input is called automatic gain control (AGC) or automatic volume control (AVC). The most common type of AGC for tube-type receivers is shown in **Fig. 49.** Its operation is simple The amplification of a tube is dependent on the voltage of its grid. Up to a point, the higher the negative voltage, the lower the amplification. So we simply take a part of the negative voltage output from the receiver detector and apply it to the grid of one of the *if* amplifiers. Then the stronger the received signal, the more negative the output from the detector and the less amplification in the tube. This in turn reduces the negative voltage and the receiver tends to have a fairly constant output. Normally, the AGC voltage is applied to both *if* and rf amplifiers for best results.

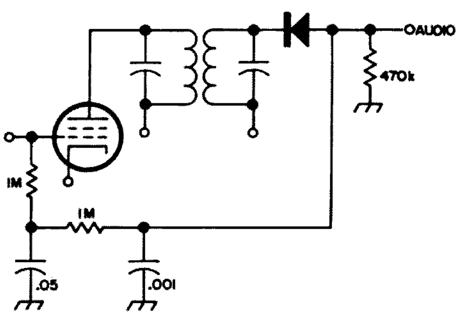


Fig. 49. The conventional AGC system used in tube-type receivers.

Of course, we really only want to reduce amplification on strong signals. The best AGC circuits should leave the weak signals alone. One way to do this is shown in **Fig. 50** It is called delayed AGC. A separate diode is used to detect a voltage for AGC. This diode is connected to a point which is slightly positive, such as the cathode of an audio amplifier. Then the diode will not conduct until it reaches a point determined by the positive voltage. This prevents the AGC from reducing the amplification of any amplifiers on weak signals.

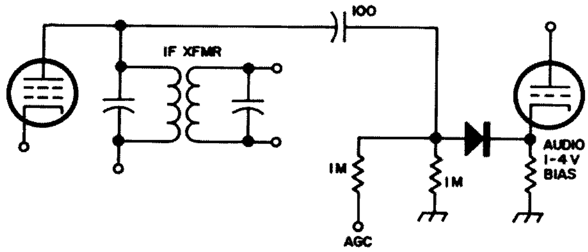


Fig. 50. Delayer AGC acts only on strong signals.

For reception of single-sideband signals, a special type of automatic gain control is needed. SSB comes in fast bunches with space between the bunches. Thus the AGC should act very quickly when a signal is received (fast attack), yet keep the receiver gain at about the same level for a short while after the burst in case another is coming (slow delay). The one-way conduction of a diode provides this action in the "hang" diode circuit shown in **Fig. 51.** The diode conducts when there is a negative voltage from the AGC detector on its cathode (in other words, when a signal is received). This charges the capacitor quickly and acts on the controlled stages. In the spaces between words or syllables, the capacitor supplies an AGC voltage to the controlled stages; there is no conduction from the capacitor back to the detector because the diode will not conduct in that direction. The size of the capacitor should be chosen for the desired AGC characteristics. In some receivers, a choice of values is available.

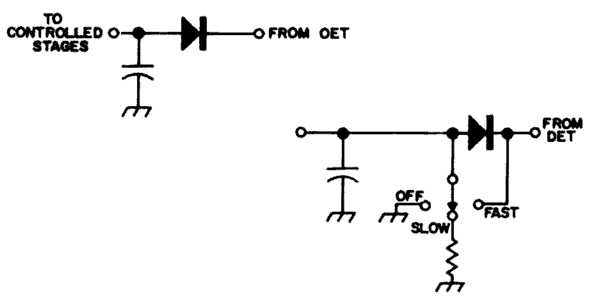


Fig. 51. "Hang" AGC for SSB/CW reception.

Fig. 51 also shows a simple type of switching to provide fast, slow or no AGC action.

Transistor AGC

Transistor automatic gain control is not as simple as tube AGC. Conventional transistors have a number of properties that complicate things slightly. There are three ways to arrange AGC in a transistorized receiver. Two are fairly common; the third is little used.

The simplest type of transistor AGC is shown in **Fig. 52.** It is called reverse AGC, since increased AGC voltage gives reduced current. In this type of AGC, the gain of the transistor is reduced by decreasing the emitter current, usually by controlling the base bias. As shown in Fig. 52, the bias of the transistor must be negative for the transistor to amplify. The AGC voltage is positive, so increasing it decreases the negative bias and hence the gain. As the current through the transistor decreases, the input and output impedances increase, resulting in greater selectivity with strong signals than weak. The transformer impedances can also be designed to be matched with weak signals so that the mismatch with strong signals will reduce the gain in addition to the transistor reduction.

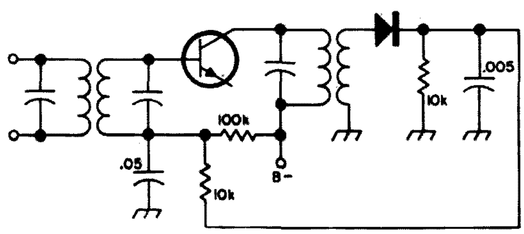


Fig. 52. Reverse AGC for a transistor-receiver.

In the other type of common AGC, called forward AGC, increased AGC voltage causes increased current to flow in the stage (though the reduction in gain is actually a result of decreased emitter voltage). The schematic of the forward AGC system shown in **Fig. 53** is identical to that for reverse AGC except that the AGC voltage is reversed (by reversing the diode detector) and a resistor is added in series with the collector transformer winding. In this circuit, increasing AGC voltage increases the bias on the transistor, causing it to draw more current. This increased current causes a larger voltage drop across the collector series resistor, which reduces the voltage on the collector of the transistor. This results in less gain. Forward AGC offers greater reduction in gain than reverse AGC and better strong-signal performance. As the current through a transistor increases, its impedances drop to low values which decreases the voltage across the transistor. Forward AGC has a few disadvantages: an amplifier may be needed to get adequate AGC voltage, the selectivity of the controlled stage is reduced, and the stage is detuned with strong signals. These last two problems may be minimized by delaying the AGC so that it does not act on weak or moderate signals.

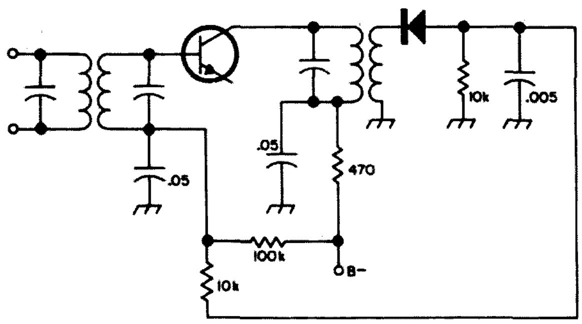


Fig. 53. Forward transistor AGC.

Reverse AGC is commonly used for inexpensive portable receivers where it's unlikely that an external antenna will be connected. Forward AGC is more suitable for receivers which are likely to have to handle strong signals. Both types of AGC may be used in some receivers. For example, forward AGC on the rf stage can be used to handle strong signals and reverse AGC could be used on the first *if* stages to maintain the proper bandwidth with strong signals. Incidentally, AGC should never be applied to the *if* amplifier feeding the detector; this stage usually needs to furnish quite a bit of power and it should be adjusted for best power-handling capability.

The other type of transistor AGC involves an attenuator rather than just reducing the gain of one or more of the amplifiers in the receiver. Diodes, transistors and other devices can be used for this purpose. The advantage of this approach is that each transistor amplifier can be designed for maximum gain, power-handling capacity, or lowest noise figure without any need to change the conditions with varying signal strengths. Most of these schemes are considerably more complicated than the simple circuits discussed above and are rarely needed in practical receivers.

A simple auxilliary AGC circuit used in most practical receivers is shown in **Fig. 54.**

The circuit is similar to conventional AGC circuits except that a diode is added as shown. The diode is reverse-biased under normal conditions (for weak or moderate signals) with its cathode more positive than its anode. However, at a certain point with a strong signal, the diode becomes forward biased and this causes it to have very low impedance. This low impedance is shunted across the transformer, causing a reduction in gain.

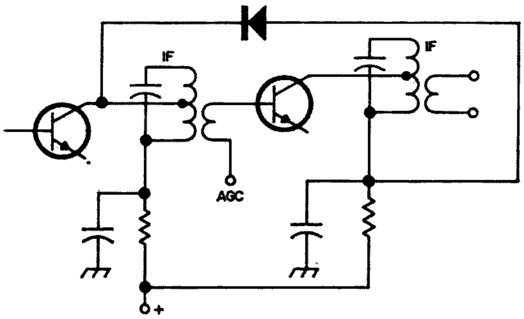


Fig. 54. An auxilliary AGC diode improves AGC action.

Many types of detectors, especially those used for SSB, FM and CW, make no provision for AGC output. A simple auxilliary AGC detector may be added in the *if* amplifier string to provide this voltage. Such a detector is shown in **Fig. 55.** It is arranged for positive output, but may easily be reversed for negative AGC voltage. The coupling capacitor should be very small to reduce the loading of the transformer.

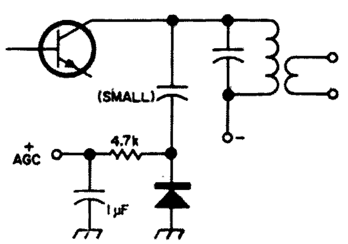


Fig. 55. An auxilliary AGC detector can be used with a product detector for SSB/CW.

AFC diode

Automatic frequency control circuits are used in many FM and TV sets as well as in commercial SSB and teletype receivers to keep locked on frequency even though the receiver or transmitter oscillator might drift slightly. The control voltage for AFC circuits is obtained from a phase detector, generally a discriminator, which provides a negative voltage if the drift is in one direction, a positive voltage if it's in the other direction, and no voltage if there is no difference in frequency. (Of course, the circuit can also be offset so that 5 V, for example, is the voltage output if there is no difference.) This control voltage is applied to an oscillator in the receiver in such a way that it varies the frequency to keep in lock. Though the oscillator can be arranged so that the control voltage varies the transistor capacitance to keep in lock, it's usually easier to use a voltage-variable capacitor diode (varicap or varactor) as shown in **Fig. 56.** This schematic is designed

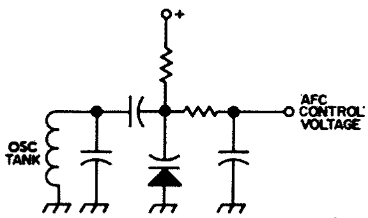


Fig. 56. A varicap is often used to provide automatic frequency control. The control voltage is provided by a discriminator.

for a conventional broadcast FM receiver; a simple filter is included to eliminate the FM deviation and a small amount of reverse bias on the diode for linear operation. The coupling capacitor should be as small as possible to simplify the adjustment of the system and prevent the characteristics of the diode from having too much effect on the oscillator—diodes have much lower Q than the other capacitors used in oscillator circuits. The diode can be a diode designed for this use (such as the Amperex 1N3182 at about 60c) or can be a small silicon diode or silicon transistor junction.

Varicap tuning

Tuning capacitors are large, expensive, fragile and hard to control remotely. But varicap diodes are small, cheap, rugged and give the amount of variation necessary for easy to control. There seems to be a pretty good future for varicaps n tuning applications. Only specially processed varicaps can use in broadcast receivers, but many others can be used for more restricted ranges. Special diode networks can be designed so that one potentiometer (which can be far from the rest of the equipment) can track both rf and oscillator stages. Varicaps, generally speaking, have lower Q's than air capacitors, so will not provide quite the selectivity of conventional tuning capacitors in most cases. This is rarely a problem,

though. It's beyond the scope of this article to go into the design of wide-range, tracked tuning networks, but the manufacturers of variable capacitance diodes have published information for this purpose. **Fig. 57** gives the basic type of circuit.

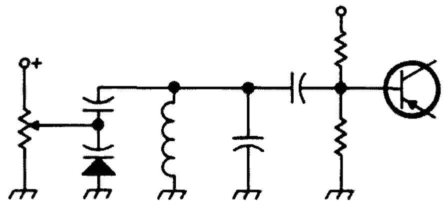


Fig. 57. An rf stage or oscillator can be tuned with a varicap.

Transmitters

Audio clippers

Many AM and FM transmitters contain audio compressors and clippers which increase the average level of modulation ("talk power") transmitted without causing overmodulation. Probably the simplest type of peak clipper is that shown in **Fig. 58A.** Here two low-voltage zener diodes are put in series across an audio amplifier stage where there is enough voltage to cause the zeners to clip. Alternately, as shown in the **Fig. 58B,** parrallel-connected germanium or silicon diodes can be used. They have the advantage over the zeners that they will clip at lower voltages (0.3 or 0.6 volts). As this type of circuit simply clips off the tops of the signal, it generates many strong harmonics which must be filtered out after the clipping. A simple resistor-capacitor low-pass filter will be adequate in many cases, though a more selective L-C filter is better.

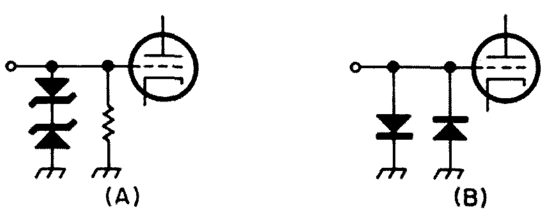


Fig. 58. Simple clippers can be made from zener diodes or silicon diodes.

A more satisfactory filter is shown in **Fig. 59.** The clipping level of this filter can be adjusted by changing the negative voltage applied to the anodes of the diodes. This circuit includes a low-pass filter.

Neither of the clipper circuits shown is useful for SSB in most cases. SSB clippers must operate on the rf envelope rather than the audio.

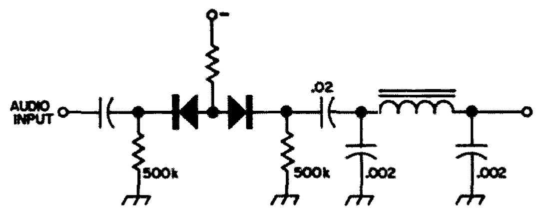


Fig. 59. A good clipper for AM or FM use includes adjustable clipping level and a harmonic filter.

Audio compressor

An audio compressor is shown in **Fig 60** This circuit is interesting, but it has a few disadvantages, including a loss of up to 60 dB. It does keep the output constant within 1 dB for 20-dB change in input. With the values shown, an input of 0.2 to 6 V gives about 5 mV output.

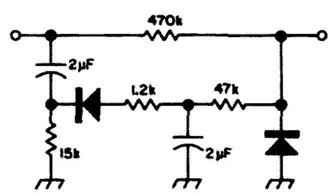


Fig. 60. The compresor can provide 25-dB compression, but at the expense of up to 60-dB loss.

Negative peak clipping

There has been a great deal of discussion among hams about negative peak clipping. Many who have tried it are very enthusiastic, but others have proved that, theoretically, it is neither necessary or desirable. Apparently a properly operating modulator well-matched to a correctly adjusted power amplifier has no need for negative peak clipping. On the other hand, simple gear which is not optimized can make good use of negative peak clipping to help reduce overmodulation and splattering. Two circuits are shown in **Fig. 61.** One uses series

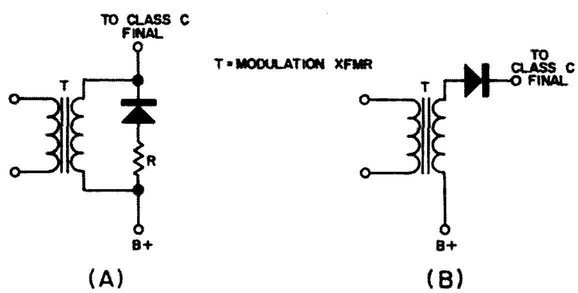


Fig. 61. The need for high-level negative-peak clipping is often debated, but its value is championed by many.

clipping and the other, parallel. The series circuit is obviously easier to install, and in view of the fact that this type of negative peak clipping is so cut-and-dry, it is recommended. Silicon power diodes suitable for the voltages encountered should be used.

FM modulator

While the battle between SSB and conventional AM has certainly been decided in favor of SSB at high frequencies, SSB hasn't threatened FM for commercial VHF use. FM has many overwhelming advantages over AM, and a number of advantages over SSB. FM has never been given a very fair test by hams, but it has been completely accepted for most VHF communications use. Narrow-band FM, as must be used on high frequencies, is not very attractive except in its simplicity and noise reduction, but wide-band VHF FM is an excellent communications medium and is becoming more and more popular for fixed-frequency net operation. FM is especially useful with transistor transmitters, as an FM transmitter can be much simpler and cheaper than an AM or SSB transmitter of equivalent power output. A simple direct FM modulator using a variable-capacitance diode is shown in **Fig. 62.** A regular varicap or varactor is best for this circuit, but almost any conventional silicon diode is usable. The audio signal input varies the bias on the diode causing a capacitance change, which varies the frequency of the oscillator. The oscillator is normally fairly low in frequency. Its output is multiplied to the VHF range to get sufficient deviation. The oscillator (including the diode) should be very stable so the only FM produced is intentional. Incidentally, the battery is used to set the bias of the diode to the most linear part of its voltage-versus-capacitance curve. It's interesting to experiment with this bias voltage; it is possible to produce greater deviation in one direction than the other. This may be desirable when the signal is being received by the slope-detection method on a receiver not designed for FM.

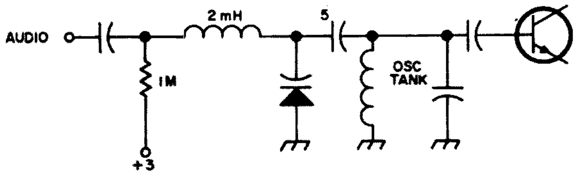


Fig. 62. A diode can be used for direct frequency modulation.

Balanced modulators

A fundamental circuit in an SSB transmitter is the balanced modulator. There are many different types of balanced modulators, and some must obviously work better than others. Unfortunately, exhaustive comparative tests on the circuits have not been published, as far as I know, and almost every SSB transmitter diagram published has used a different type of modulator. However, two which have been found excellent are shown in **Fig. 63** and **64.** One

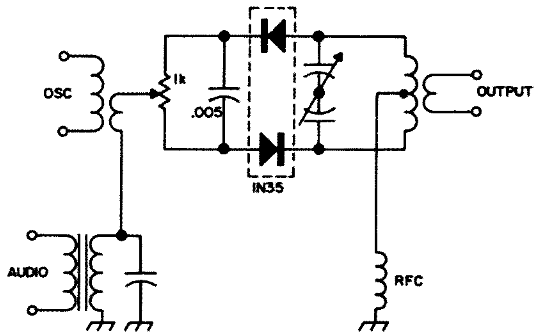


Fig. 63. This is a popular balanced modulator for generating DSB (and eventually SSB).

uses four diodes in a bridge, and the other uses two diodes. The diodes in these circuits should be matched if possible. Matched pairs of diodes are available (for instance, the 1N35 is a matched set of two 1N34's), or they can be matched by measuring the forward (low) resistance of a number of diodes with an ohmmeter and choosing the ones which have the closest values. Both of the circuits shown produce a carrierless double-sideband signal from an rf signal and audio.

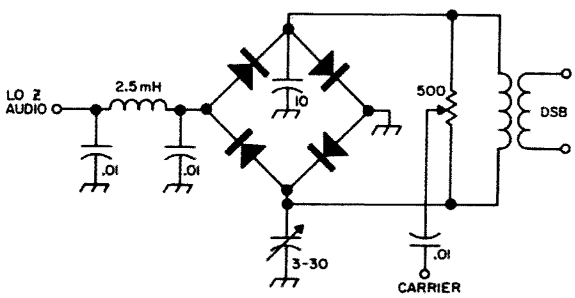


Fig. 64. This is a bridge balanced modulator for SSB.

Sideband switching

A sideband transmitter usually has some provision for operating on both upper and lower sidebands. There are a number of ways to do this, but one of the simplest is shown in **Fig. 65.** Here simple diode switches are used to select either the upper- or lower-sideband crystal by grounding the desired

crystal and presenting the other crystal with a very-high-impedance path to ground. As the circuit is shown, applying a positive voltage will select the lower-sideband crystal, and a negative voltage the upper. The voltage should be a little higher than the peak voltage across the crystal.

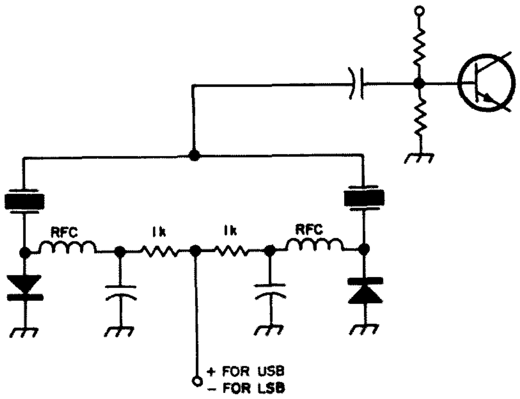


Fig. 65. A pair of diode switches can be used to select upper-or lower-sideband-generating crystals.

Another useful diode switch is shown in **Fig. 66.** This circuit is especially useful in transceivers. A positive bias voltage selects the first input and a negative one the second input. Here again, the bias voltage must exceed the peak voltage in the circuit.

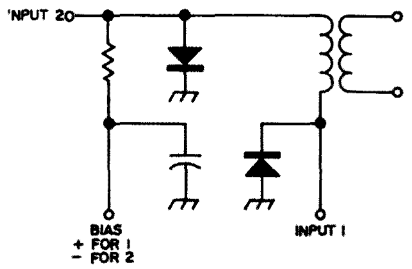


Fig. 66. These diode switches can be used in a transceiver or other type of equipment to select either of two inputs.

RTTY keying

The simplest way to shift a VFO frequency slightly for high-frequency FSK radioteletype is to use a diode switch as shown in **Fig. 67.** The shift required is only 850 Hz or less, which is easy to get in most high frequency VFO's. The trimmer capacitor is adjusted for the proper shift.

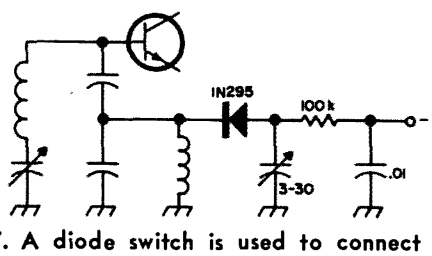


Fig. 67. A diode switch is used to connect a small capacitor to a VFO to shift its frequency slightly for radioteletype.

Varactor multipliers

Few components have simplified the work of the VHF engineer or ham more than the power varactor diode. Currently available varactors can produce as much as 30 watts or more at 450 MHz from a 40-watt 150 MHz source. These varactors are very efficient, too, with efficiencies of 75% fairly typical. Other varactors are excellent for generating power at 10 GHz or more. Step-recovery diodes are recently developed varactors that are even more remarkable in producing power at microwave frequencies from simple circuits. Many cheap, common diodes (and transistor junctions) make excellent low-power varactors. Silicon power diodes can be used at low frequencies, and fast silicon diodes such as the 1N916 are excellent as high as 1GHz in many uses. A general varactor doubler is shown in **Fig. 68.** Notice that the input and output

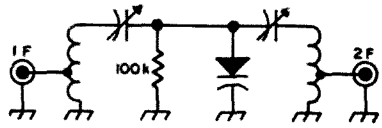


Fig. 68. This is a basic varactor doubler.

circuits are series tuned, with the diode in parallel. This is the most efficient and convenient type of varactor multiplier, since power varactors are generally designed for grounded cathode operation. The bias resistor is not usually critical, though in general, low values give the best linearity and high values the best efficiency. Applying a slight bias to the cold end of the resistor, instead of grounding it, often improves the efficiency slightly. While not shown, a varactor doubler can be built with two parallel tank circuits and a series diode. This is not as efficient as the parallel circuit, but it is often more convenient for low-power receiver multipliers and signal sources, especially if they use popular grounded quarter-wave coaxial or trough-line tanks. A varactor tripler or quadrupler

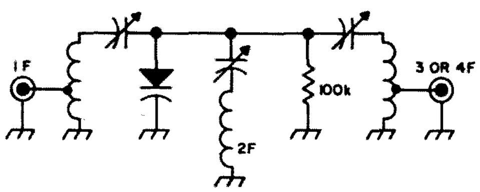


Fig. 69. "A" is a varactor tripler or doubler.

is shown in **Fig. 69A.** It requires an idler circuit tuned to the undesired second harmonic of the input. The tuning of this idler can be critical for best results, but it is often omitted in applications where low efficiency is satisfactory.

Fig. 69B shows a practical 144-to-432 MHz tripler using an Amperex 1N4885 diode ($15). 25 W input at 144 gives 17 watts of output at 432 MHz.

Since varactor multipliers are such excellent generators of harmonics, they can cause severe interference in transmitters and spurious responses in receivers. They can not only multiply by whole numbers, but can mix these harmonics together to produce strong signals at 3/2, 4/3, 5/2 and other multiples of the fundamental. Consequently, varactors should always be used with selective filters except where these extra signals will cause no problems.

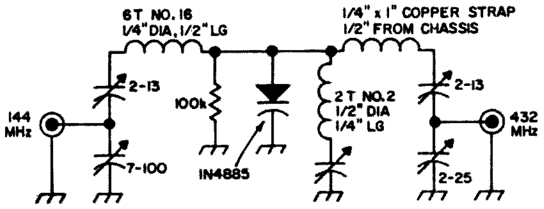


Fig. 69B is a practical high-power varactor tripler.

Transmitter spotting switch

Every CW transmitter should have some method of spotting its frequency without putting a signal on the air. Some of the schemes which have been published are quite involved; many even require stealing voltage from the receiver for spotting. A far simpler approach uses one diode along with one single-pole-single-throw switch. It's shown in **Fig. 70.** When the spot switch is thrown, the diode is reverse biased, so it does not conduct and only the oscillator can draw current. However, in normal transmission, when the key is depressed, the diode is forward biased, so all the stages in the transmitter can operate. The diode should have high back resistance. A silicon power diode is recommended.

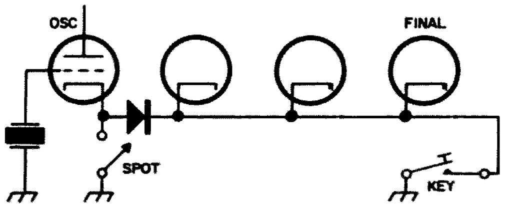


Fig. 70. A diode can be used for very simple spotting in a CW transmitter.

Test Applications

Field strength meters

One of the most useful pieces of equipment in any ham shack is a field strength meter. While FSM's can be bought for very little from any big radio supply house, they're so simple and easy to build that most hams make their own. The simplest type of FSM is untuned, and can be used at any frequency from below the broadcast band to UHF. **Fig. 71** shows such an FSM. It uses only four components: a non-critical rf choke, a germanium diode of almost any type, a small capacitor, and a meter. This

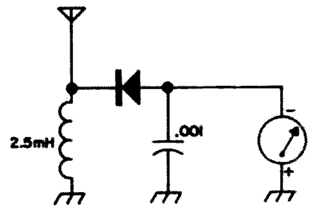


Fig. 71. A simple field-strength meter.

circuit gives a very nonlinear, relative reading. A slightly better FSM is shown in **Fig. 72.** It is less frequency-dependent than that in **Fig. 71** at it doesn't contain an rf choke. It uses a resistor to help linearize the meter. This circuit uses a voltage-doubling detector for high sensitivity, a variable resistor for adjusting the deflection on the meter, and a choice of meter output for adjusting transmitters, or a pair of magnetic headphones for monitoring AM transmissions.

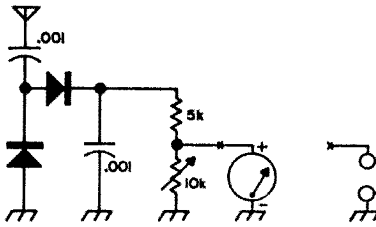


Fig. 72. This voltage-doubling field-strength meter-monitor is not frequency selective.

The mobiling ham has a special problem. He needs a good FSM to get the best performance from his usually inefficient antenna, but can't use a meter which is affected by other nearby transmitters. A solution to his problem is the mobile FSM shown in **Fig. 73.** It uses a silicon diode which doesn't conduct except on very close high power transmitters (his). This design also uses a normal BC antenna for pick-up, yet requires no switching.

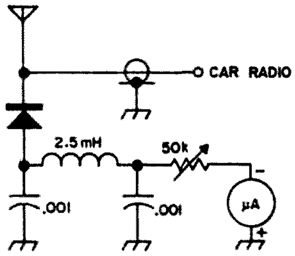


Fig. 73. A special type of FSM for use in a car.

Another simple rf detector-FSM is shown in **Fig. 74.** It's called an rf sniffer, and is especially useful for neutralizing transmitters and detecting the presence of small amounts of rf in both transmitters and receivers. The size and shape of the loop of wire is not critical, but it should be insulated for safety.

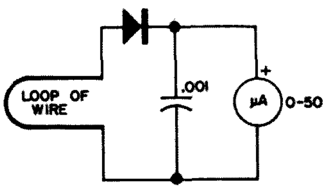


Fig. 74. The rf sniffer is a wide-range sensitive rf detector.

Wavemeters

A slightly more sophisticated rf detector is shown in **Fig. 75.** It includes a tuned circuit for differentiating between frequencies. This type of instrument is very useful in adjusting transmitters since it helps to prevent transmitting on the wrong harmonic of a crystal-controlled oscillator. The tuned circuit should tune the required range, and can be tapped as shown for the best selectivity. Bandswitching is necessary for ranges of more than about 3 to 1. This type of circuit is usually called a wavemeter. It can also be used as a field strength meter, of course.

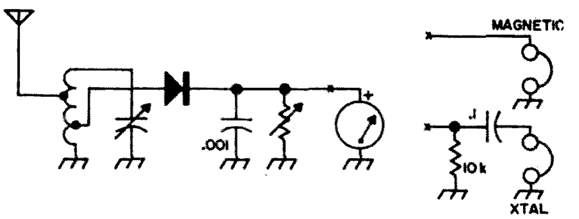


Fig. 75. A wavemeter is simply a FSM tunable to to frequency. It is especially useful for checking transmitter harmonics.

A good wavemeter-FSM for the VHF man is the simple tunable, voltage-doubling six-and two-meter unit shown in **Fig. 76.** It can be used to make sure that he's transmitting on the right frequency, help him adjust his transmitter for maximum output, and monitor his modulation if he's on AM.

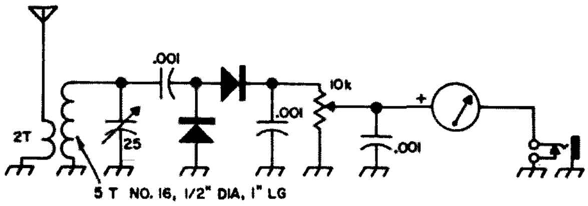


Fig. 76. This tunable VHF wavemeter-FSM-monitor covers six and two meters.

The Uhfit, shown in **Fig. 77,** is a FSM-monitor using a capacitively tuned, quarter-wave line. It tunes 215-450 MHz, covering both the 220 and 432 MHz bands. The Uhfit can be built from any type of solderable metal, or from copper-clad board.

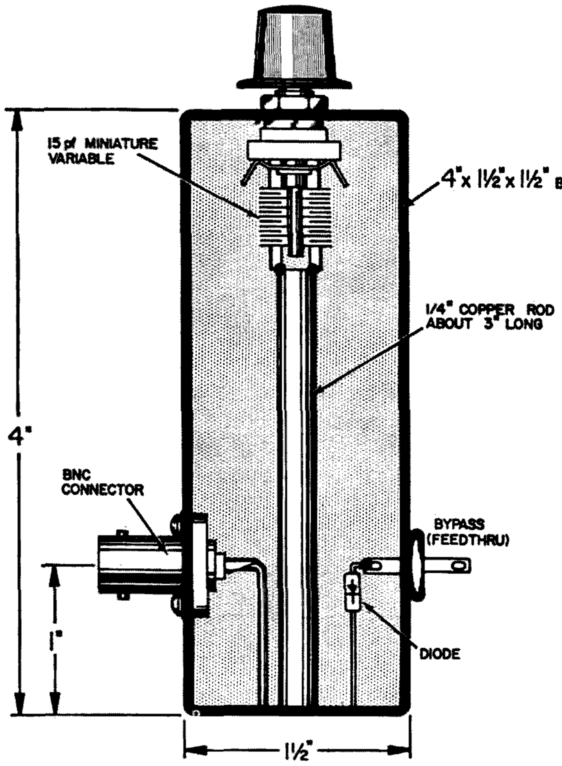


Fig. 77. The *Uhfit* is a general-purpose wavemeter and monitor.

RF probe

A necessity for the ham experimenter is an rf probe which can be used to detect and measure small rf voltages. This type of probe can be used with both voltmeters

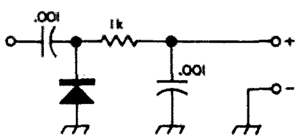


Fig. 78. A general-purpose rf detector probe for use with an oscilloscope or voltmeter.

and oscilloscopes for alignment, troubleshooting, signal tracing and many other jobs. A good rf probe for the HF and VHF ranges is shown in **Fig. 78.** The capacitors should be button or other good HF units for VHF use. They can be increased slightly in value for use down to 455 kHz or lower.

Dummy load

Every ham needs a dummy load for his transmitters. It can be used for tests to avoid transmitting a signal that could cause interference to other stations. A dummy load is simply a non-reactive resistor which matches the output of a transmitter, usually 50 ohms. A dummy load is most useful when it contains an rf voltmeter so it can be used for determining power by the familiar equation, $P = E^2/R$. See **Fig. 79A.** For low power, the diode can be connected directly across the resistor, but for higher power, enough voltage may be developed to damage the diode. For example, a typical 1N34 diode, which is often used for rf monitoring, has a PIV of only 60 volts. Assuming that the waveform applied to it is a perfect sine wave, which is unlikely, a voltage of about 20 RMS is the maximum it can take. However, that's only 8 W. Therefore, most dummy loads of this type use a voltage divider, such as shown in **Fig. 79B.**

This step-down in voltage subjects the diode to much lower voltage (about 1/100th in this case). Then, if the 50-ohm load can stand the power, the same diode could be used for up to 800 W. This type of divider is, unfortunately, quite sensitive to frequency, so cannot be trusted at high frequencies (say over 30 MHz) unless calibrated. It is possible to compensate for this by adding a small capacitor across either the large or small resistor in the voltage divider, and that will increase the maximum usable frequency somewhat. Here again, though, it must be checked against a reliable standard.

One thing to be very careful about with all of the rf voltmeters mentioned above is that they are peak-reading instruments. That means that on a perfect sine wave, they indicate about 1.4 times the RMS value of the rf if they're used with a high resistance dc voltmeter. The RMS value is what we usually use. However, it is easy to compensate for this by multiplying the value by 0.7. A more serious problem is that for wave shapes other than sine, the

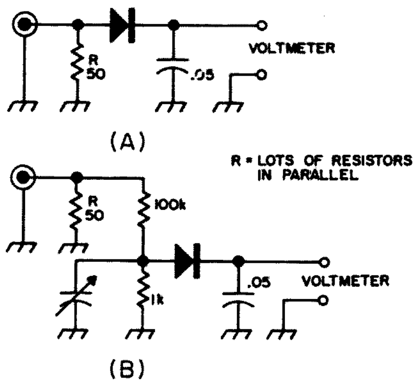


Fig. 79. A dummy load should be used for all possible transmitter testing. An rf voltmeter connected to the dummy load makes it a wattmeter. A single diode is limited in voltage rating, so a voltage divider must be used for high power.

relation between the peak value and the RMS value may be unknown, and some waves may have peak values which are very much higher than 1.4 times the RMS. For example, a wave with high out-of-phase third-harmonic content can read very high. This is often responsible for such statements as the 99% or even 75% efficiency sometimes claimed for two meter transmitters or varactor multipliers. There is no simple, universal solution to this problem.

SWR bridge

There are a number of instruments which can help you find out whether your antenna is matched properly to its feed line. Most hams use an SWR bridge, which measures the degree of mismatch in the line, but these SWR bridges really tell very little unless they're installed at the antenna feed point rather than at the transmitter. A basic and very popular type of SWR bridge is shown in **Fig. 80.** This device can be left in a transmission line when transmitting and can be used to tune a transmitter for maximum output. There are many variations on this type of bridge, using slightly different electrical or mechanical arrange-

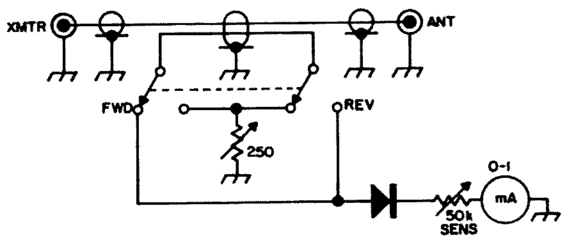


Fig. 80. An SWR bridge is invaluabe for adjusting an antenna. The critical part of the bridge is a piece of coax cable with an extra wire inserted between the cable dielectric and the shield.

ments for easier construction or improved performance. The bridge shown uses a piece of coax cable with an extra small piece of wire slipped between the inner insulation and the coax shield. The piece of coax and the other components should be kept short for VHF operation, with a symmetrical arrangement of parts. In use, the bridge sensitivity control is adjusted for a full-scale reading with the switch in the forward position, then the switch is thrown to the reverse position. The lower the reading the better, and a zero reading indicates (at least in theory) a perfectly matched line with an SWR of 1.00:1. In practice, this type of bridge is not that trustworthy, but it still can be useful in helping you tell whether your antenna is close to 50 ohms.

Antennascope

Another type of bridge used for matching antennas is better in that it can tell you what your antenna impedance is instead of just indicating whether it is close to 50Ω. This is the simple impedance bridge, called the antennascope, shown in **Fig. 81.** This bridge is designed for low power operation —a grid dip meter usually gives plenty of power. It should be built very compactly with short leads. The potentiometer should be of high quality; an Allen-Bradley Type J is fine. The bridge can be calibrated with regular composition resistors. Simply connect the resistors in turn to the antenna terminal and adjust the pot until the meter reading dips to zero. Then mark the value of the resistor by the pot pointer. In use, the meter reading will not null completely except for resistive loads, so it will not read zero for reactive antennas. Nevertheless, the minimum reading will occur at the approximate impedance reading. Remember that all antenna bridges should be used between the antenna and the transmission line.

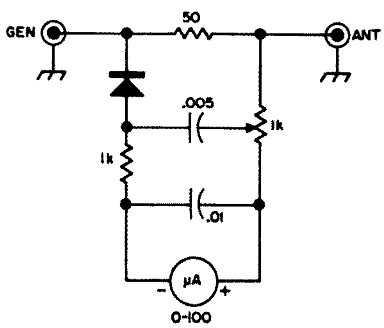


Fig. 81. This antennascope is a simple antenna impedance bridge. It should be constructed compactly for best high frequency use.

James Dandy Mixer

A little-known but very useful simple piece of test equipment is the untuned mixer, or James Dandy Mixer, as W2DXH calls it. This gadget, as shown in **Fig. 82,** has many uses. It can be used as an untuned detector or monitor, or for making an impromptu frequency meter, neutralizing transmitters, finding VHF parasitics. The James Dandy Mixer has two inputs of 50 ohms, which are fairly well isolated from each other. Shorting or opening one, has little effect on the other. This mixer is one of those instruments that finds many uses after it is built, and is so easy to build that it belongs in every lab or shack.

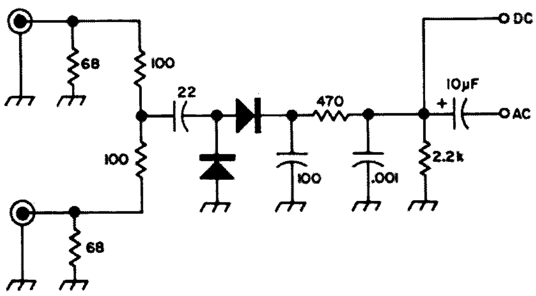


Fig. 82. The James Dandy Mixer is a general-purpose untuned mixer useful as an impromptu frequency meter, receiver, detector, etc.

Signal generator modulator

A simple diode AM modulator for an unmodulated signal generator is shown in **Fig. 83.** It can be used with an audio generator and early BC-221, for example, for receiver alignment.

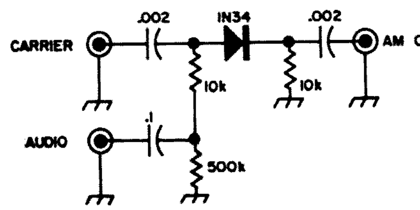


Fig. 83. This amplitude modulator can be used to modulate the output of any low-level CW source.

Tachometer/audio frequency meter

Diodes can be used to form a simple audio frequency meter. The circuit is shown in **Fig. 84.** This circuit requires a constant 10 V RMS input, which may be set by a

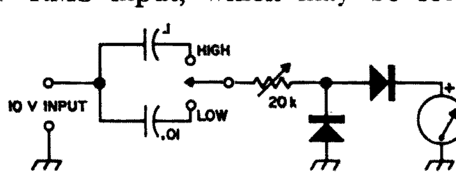


Fig. 84. This audio frequency meter must be calibrated before use. It requires an input of 10 V.

pair of zener diodes or with the help of an audio voltage meter. The circuit shown covers 20-5000 Hz; the scales are not linear, and must be calibrated before use.

A more satisfactory frequency meter for audio frequencies is shown in **Fig. 85.** Its scale is linear, and the input is automatically set to the right level by the zener diode or diode-battery clipper over quite a wide range. The same circuit can be used as an automobile tachometer. Simply connect the input to the high side of the points in the car. It can easily be calibrated on about 12 Vac. Remember that 1 Hz = 60 rpm, so 60 Hz = 3600 rpm.

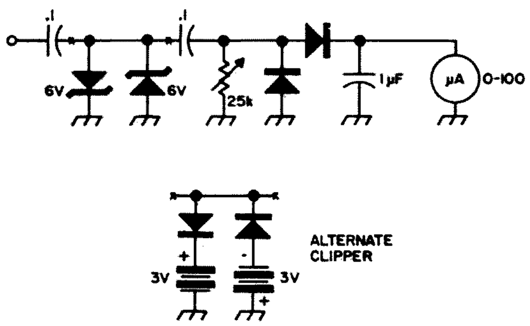


Fig. 85. This audio frequency meter-tachometer is self limiting and linear reading. Either two zeners or two conventional diodes and batteries can be used to set the proper input voltage.

Noise generator

A useful piece of equipment often used in aligning receivers is a noise generator. A noise generator is a source of controllable noise, more-or-less independent of frequency. For instance, the noise generator shown in **Fig. 86** provides noise from below the broadcast band all the way to 500 MHz. It is adjustable in output by the potentiometer. The capacitor should be a UHF button mica or ceramic feedthrough for best results. Most surplus 1N21 silicon diodes can be used, but some generate more noise than others. The resistor across the output should have the same value as the input to the receiver under test. Leads should be as short as possible. This type of noise generator is useless for quantitative tests as there is no simple relation between the amount of current flowing through a diode and its noise output, but the generator is very useful for adjusting a receiver for lowest noise figure. The procedure is to adjust the receiver while turning the noise generator on and off. You should adjust for maximum rise in noise when the generator is turned on. Incidentally, the polarity of the diode must be checked carefully. If it is reversed, it will be forward biased, and its impedance will be very low and in parallel with the 50-ohm resistor. Also, the impedance will change radically with varying current, making the output impedance of the device uncertain and consequently unreliable.

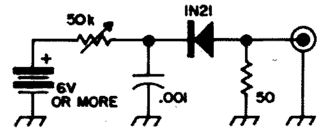


Fig. 86. A diode noise generator is very useful in aligning a receiver for lowest noise figure.

Square-wave generator

A simple square-wave generator is shown in **Fig. 87.** If a sine wave is applied to the input, an almost-square wave will appear across the two back-to-back zeners as they clip the top and bottom off the sine wave. Best waveform results when the input voltage is much higher than the output, for instance 50-V input and 5-V output. The limiting resistor must be picked for the voltage and current capabilities of the zeners.

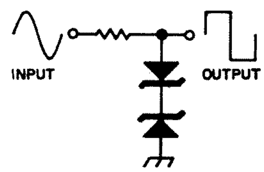


Fig. 87. Two zeners can be used to produce a highly clipped sine wave very similar to a square wave.

Sawtooth pulse generator

A simple sawtooth generator for use with simple monitor scopes is shown in **Fig. 88.** It works best with low frequency sine-wave input and very high impedance output.

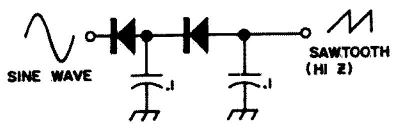


Fig. 88. This simple sawtooth generator could be added to a monitor oscilloscope.

A relative of the sawtooth generator is shown in **Fig. 89.** It can be used for generating pulses for many applications. It, too, takes a sine wave input. Among the applications of a pulse generator are adjusting noise clippers and blankers, and providing marker pulses for the time base of a scope. For instance, a 1000 Hz sine wave can

provide a pulse every millisecond (1000 microseconds).

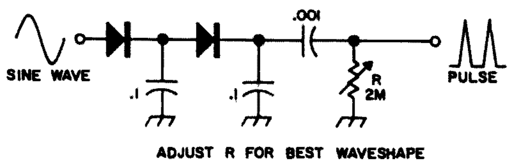


Fig. 89. A pulse generator is needed to adjust noise limiters for best results.

Miscellaneous Circuits

Dual battery supply

Many hams who operate mobile have had the embarassing experience of running their battery down by talking a bit too long. One way to avoid this is to use two batteries, one for the ham gear and one for normal car needs. However, some way must be found to keep them both charged, yet make sure that the ham battery does not steal energy from the normal battery. Schemes to accomplish this used to be complex, with heavy relays and complicated switching, but as has happened in so many cases, semiconductors have simplified the problem to almost nothing. A couple of high-current, low-voltage silicon diodes can be used as one-way switches as shown in **Fig. 90.** The

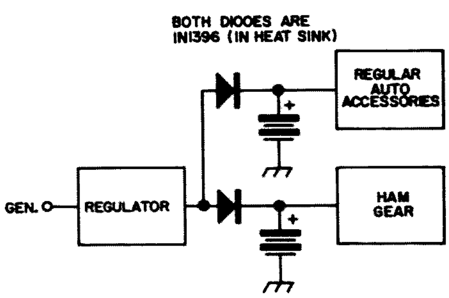


Fig. 90. Here's how to use two batteries in your car, one for ham gear and one for the rest of the car needs. The diodes act as one-way switches, keeping the batteries charged, yet preventing any power from flowing from one to the other.

diodes conduct when the generator voltage is higher than the batteries, charging the batteries, but current cannot flow in the other direction and cause one battery to charge the other. The diodes should be mounted on heat sinks in as cool a place as can be found near the batteries. Heavy wire is necessary as many amperes will flow at times. There is a voltage drop of about 0.6 V across the diodes, so it may be necessary to adjust the car voltage regulator for slightly higher output. Since charging voltage is usually 13.5 to 15 V or more, this may not be required.

Combination battery charger-power supply

It's often convenient to have an ac power supply included in equipment that is normally battery operated. Unfortunately, some switching must be provided between the two supplies so that the battery will not run down by mistake when the equipment is supposedly used on ac. One simple way to avoid this problem is to use a rechargeable battery which cannot be overcharged, and float it across the power supply as shown in **Fig. 91.** In this circuit, if the power supply is plugged into ac, the battery will be charged and the equipment can also be operated at the same time. If the ac supply is disconnected, the equipment operates from its battery supply with no manual switching. The battery cannot discharge through the power supply because of the one-way action of the diode bridge.

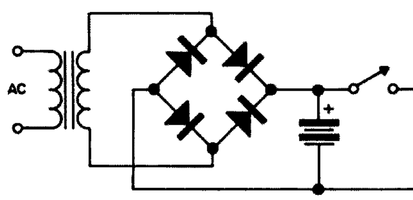


Fig. 91. A battery can be floated across a power supply, keeping it charged and providing automatic switching from ac to battery power.

Code transmission

The simplest way to transmit code for practice is to use a tape recorder to modulate a transmitter. However, this produces an AM or FM signal rather than CW (except possibly on SSB). It's generally better to transmit a CW signal as used in most communications. One way to do this is shown in **Fig. 92.** Here the rectified audio output from the recorder operates a relay which keys the transmitter. A high-speed relay and short capacitor-resistor time constant is necessary for high-speed operation.

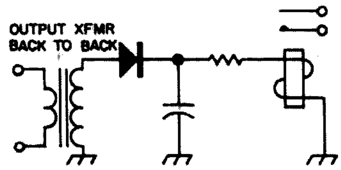


Fig. 92. A transmitter can be keyed by a tape recorder for automatic code practice with this circuit.

Code monitoring

Fig. 93 shows a simple method for monitoring the CW output of a transmitter. Antenna, choke and diode rectifier produce a dc voltage that operates a suitable code practice monitor. The monitor must be one which can operate from the keying voltage available and will turn on quickly. Some code practice oscillators operate from as little as ½ V; they would obviously be more suitable for low-power applications than oscillators requiring higher voltage. However, if you live near a broadcast transmitter, a monitor which is too sensitive may be triggered by the BC signal.

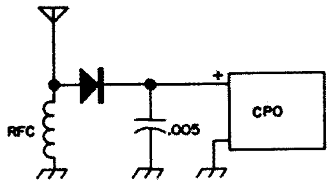


Fig. 93. A field strength meter can key a code oscillator to form a cw monitor.

Radar detector

Of limited practical use, but tremendous appeal, is a simple detector for police radar speed traps. These detectors, which consist of a diode detector in a tuned cavity and a high gain audio amplifier, are illegal in many states, but the laws forbidding them are really a waste of time because anyone who hears the police radar on his

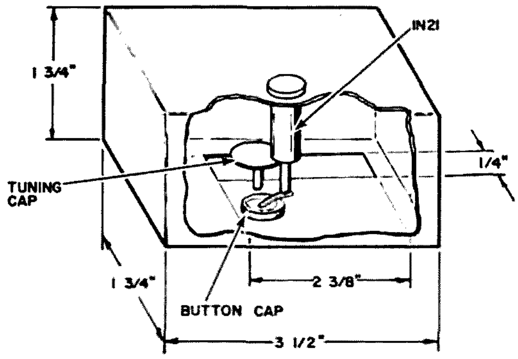


Fig. 94. This is a radar receiver; it covers a ham band as well as a police radar speed meter assignment.

receiver is already in its beam. Nevertheless, the radar detector is interesting. As a bonus, it covers some ham bands and other possibly interesting frequencies. A detector for 2.3 to 3.3 GHz, which includes some of the police radar assignments, is shown in **Fig. 94.** It can be built from brass or copper-clad circuit board. It should be followed by a very high-gain low-noise amplifier for greatest sensitivity. This receiver will pick up many signals in almost any location, but don't count on it saving you from a speeding ticket.

Zener tricks

A zener diode can replace a large, high-capacitance coupling capacitor in an amplifier, and improve the frequency response of the amlifier in the process. The direct-coupled amplifier in **Fig. 95** uses a 15-V zener in this way. High-voltage zeners can also be used in tube circuits.

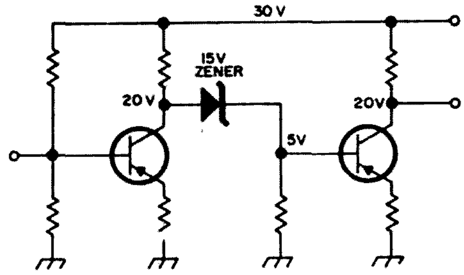


Fig. 95. Zeners can be used in dc-coupled amplifiers to replace coupling capacitors.

Fig. 96 shows a pair of diodes used to provide an artificial center tap in a push-pull transistor amplifier. This arrangement is more satisfactory than a resistive tap.

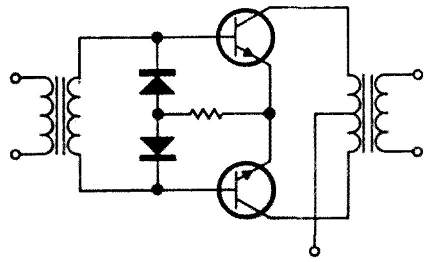


Fig. 96. Diodes can provide an artificial center tap for push-pull amplifiers.

Zeners can furnish low-impedance stable bias sources for vacuum tubes. A screen voltage zener is shown in **Fig. 97A,** and a zener in series with the tube to provide grid bias is shown in **Fig. 97B.** The resistor R may be necessary to keep the zener alive if

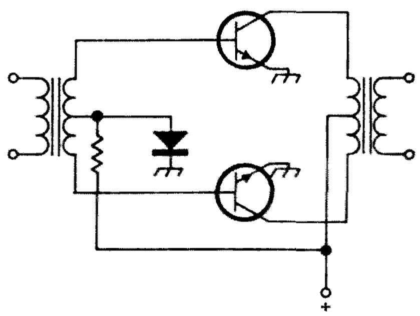


Fig. 97. A diode is often used to provide temperature-compensated bias for class B amplifiers.

the current of the tube drops to a low level or if the zener works best at a higher current than the tube.

Class B temperature stabilization

Class B transistor amplifiers are very sensitive to changes in temperature. A small resistor is generally used in the emitter circuits of these amplifiers to prevent excessive current flow at high temperatures, but resistors can waste a lot of power as well as provide varying bias. A better approach is to use a diode to maintain the bias as shown in **Fig. 98.** The diode will compensate for temperature changes because of its temperature coefficient, which is similar to that of the transistors.

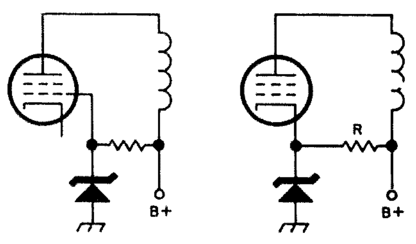


Fig. 98. A zener can furnish stable screen or grid bias for a vacuum tube.

Reverse polarity protection

Few things are as disheartening as connecting a piece of equipment to a reversed power supply and blowing out its transistors or other parts. Though this possibility has probably been over-emphasized in the past, it is true that some transistors in some circuits are very intolerant of incorrect polarity.

Fig. 99A shows a simple way to prevent this. If a diode is connected in series with the power lead, the wrong polarity will cause no problem as the equipment will simply not work. An even better arrangement is shown in **Fig. 99B.** Here the equipment will work properly no matter how you connect the power supply. The diode bridge "chooses" the proper polarity from the input voltage. In fact, it will even work on alternating current, but a filter will probably be necessary. The diodes must be suitable for the current passing through them. There is a slight voltage drop across the diodes.

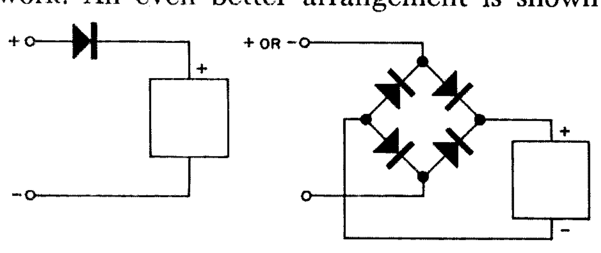


Fig. 99. These two circuits protect equipment from incorrectly polarized voltage. The single diode keeps the equipment from working when the polarity is wrong, while the bridge automatically selects the proper polarity.

Under- and over-voltage protectors

Tubes are becoming unpopular for many applications, but many are still being used. They are often expensive and critical tubes are easily damaged by excessive filament or heater voltage, such as transmitting power amplifiers and cathode ray tubes. Zener diodes can be used to protect filaments from gross voltage overloads, and with care, can also protect them from small excessive voltages. The filament voltage of most tubes used by hams should be kept within 10% of the proper value for best results and longest service. **Fig. 100** shows how a zener (or zeners) can be connected across a filament to eliminate the problem of high voltage.

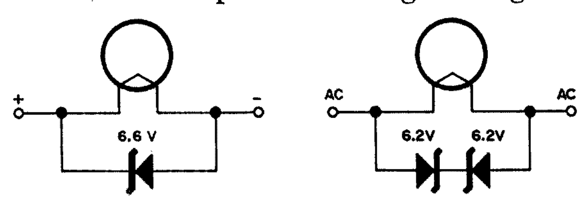


Fig. 100. Zeners can protect a delicate filament from overvoltage.

Fig. 101 shows a similar arrangement which will provide protection from high voltage for a piece of equipment of any type.

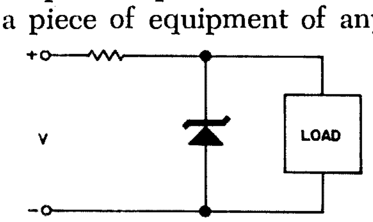


Fig. 101. A zener can protect any critical load from overvoltage.

Many pieces of equipment can be damaged from under-voltage as well as over-voltage. Many motors, for instance, will stall under low voltage, then draw excessive current and burn out. One way to prevent this is shows in **Fig. 102.** The relay disconnects the load when the input voltage drops to a value low enough to cause the zener to stop conducting. The resistor is necessary to limit zener current if the relay resistance is not high enough.

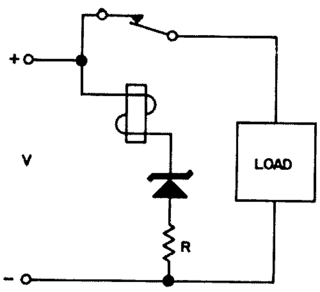


Fig. 102. This circuit will disconnect a load when voltage drops below a minimum.

Transient fields

Transformers, relays and other inductive components operating in dc circuits often generate large reverse transient voltages when their magnetic fields collapse as the dc voltage is removed. These transients can damage transistors, diodes and other polarity- and voltage-sensitive components if suitable precautions are not taken. A simple, inexpensive transient damper is shown in **Fig. 103.** A silicon diode is connected across the coil in the reverse direction. It conducts no current as long as the dc flows. When the dc is removed, the diode will short circuit any reverse-polarity voltage transient generated by the collapsing coil. The diode used must have a PIV rating greater than the voltage generated.

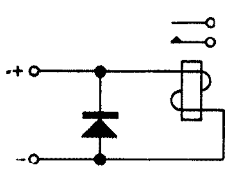


Fig. 103. A diode can damp the field generated by a coil when current through it is disconnected.

Transistor gain control

A vexing problem in transistor amplifiers is varying the gain of an amplifier without changing its dc conditions. One simple approach is shown in **Fig. 104.** Here the impedance of a diode in series with an emitter bypass capacitor is varied to change the effectiveness of the bypassing, and hence the gain of the stage.

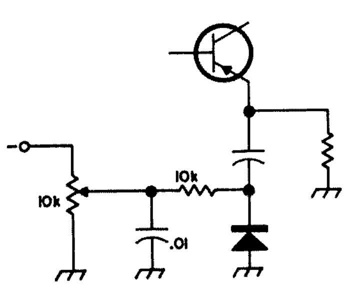


Fig. 104. A diode can control the bypassing of an emitter bypass capacitor to change an amplifier's gain.

Lamp dimmer

Fig. 105 shows a simple non-dissipative lamp dimmer. It offers only two positions, full on and half on, but that is adequate for many uses. Its operation should be fairly obvious. The diode conducts ac in only one direction, so only half the current that normally would flow through the lamp is passed. The diode must be rated for the wattage of the lamp; a 750-mA diode is satisfactory for a 60-W lamp.

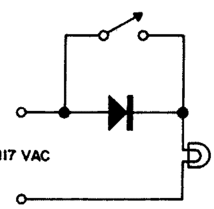


Fig. 105. This is a lamp dimmer providing two brillance positions, half on and full on.

Control circuits

Diode control circuits are among the most interesting, yet least understood, diode circuits. Some of them smack of black magic when they're not well understood. **Fig. 106** shows such a circuit. Here one switch and two wires serve to control two lamps. Do you see why it works? There is a small voltage

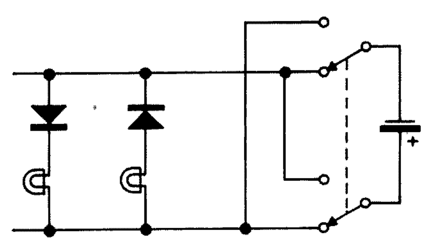


Fig. 106. Diodes can be used for mysterious switching of two lamps with one pair of wires.

drop across the diodes. **Fig. 107** is a slightly more interesting version of the same type

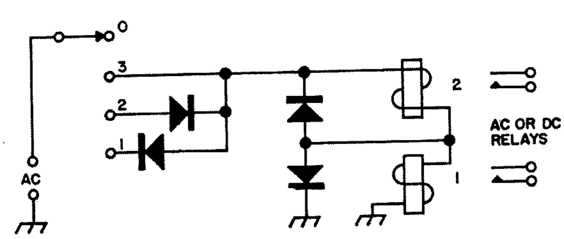


Fig. 107. This is an extension of Fig. 106. In position 0 neither relay is energized. In position 3 both are energized. In 2, relay 2 is on and in 1, relay 1 is on.

of circuit. One switch and two wires control two relays, turning them both on or off, or either one on or off, in turn.

Another interesting scheme is shown in **Fig. 108.** Here the relay receives current when the input voltage exceeds the zener

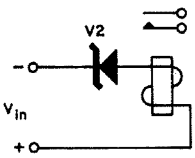


Fig. 108. An input voltage over the zener voltage energizes the relay.

voltage. **Fig. 109** is an expansion of that idea in which increasing voltages turn on the relays in sequence. This could be used for various indicators such as antenna elevators or rotators.

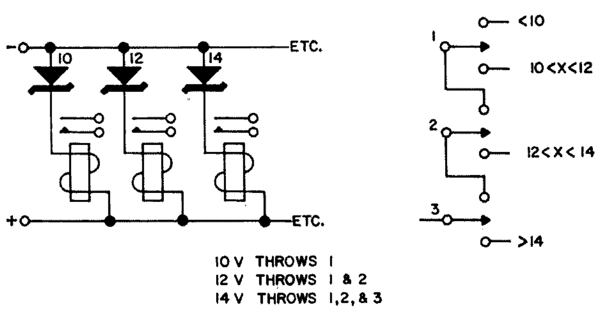


Fig. 109. In this scheme, a varying input voltage selects relay contacts in turn.

Transmit-receive switches

Diodes make excellent transmitter-relay switches. A number of manufacturers make diodes especially suited for this service. You can buy solid-state antenna switches for HF, VHF or microwave use, but they aren't cheap. For ham HF use, simple, cheap silicon power diodes make excellent T-R switches that switch very fast and provide excellent isolation and low loss. Such a circuit is shown in **Fig. 110.** It will handle quite a bit of power. **Fig 111** shows another semiconductor antenna switch. This one is a little more symmetrical than **Fig. 110** and better for VHF. The diodes should be special mic-

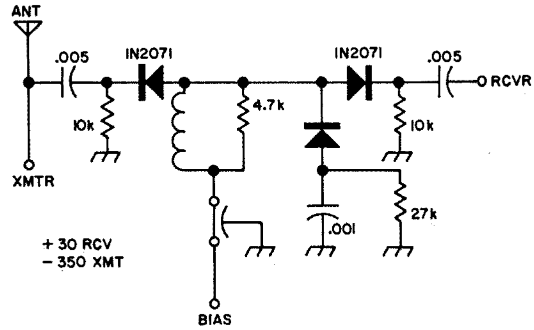


Fig. 110. This is a high-frequency antenna switch using diodes.

rowave varactors, but the circuit will likely work with common diodes such as the 1N21 if the diode ratings are not exceeded.

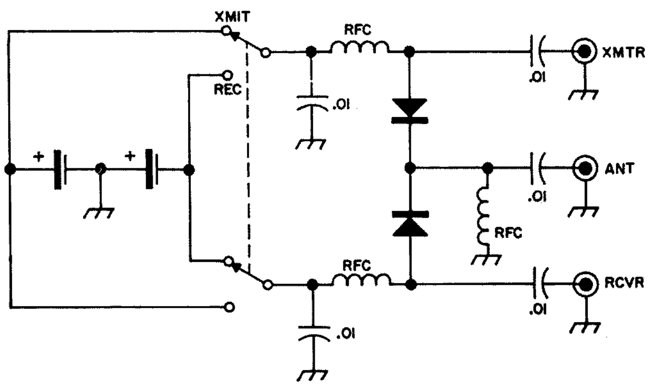


Fig. 111. This transmit-receive switch can be used at VHF if it is constructed carefully.

Testing Diodes

Probably the best way to check a diode is to display its characteristics on an oscilloscope, as described by W2DXH in the April 1967 73. Jim's checker puts a maximum of about 225 volts across the diode, so tells little about the properties of the diode under higher voltage. It is often desirable to test diodes at higher voltages. It's easy to modify Jim's circuit for this, but you have to be careful in using a higher voltage or the diode, the instrument, or you, may go up in air pollutants. On the other hand, you can test diodes at low voltages with the popular (It has appeared in almost all electronics magazines.) scheme shown in **Fig. 112.** This

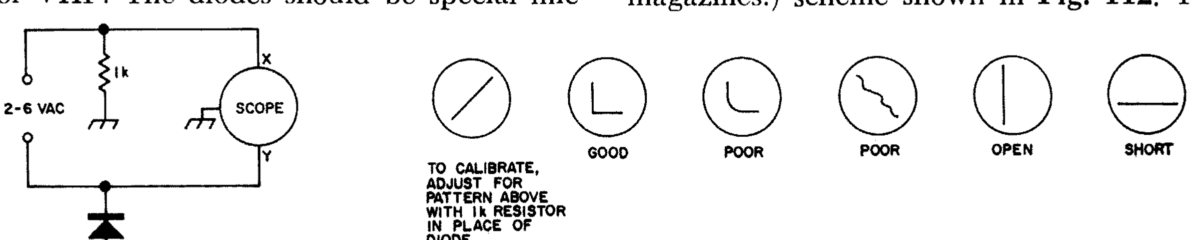


Fig. 112. One of the easiest types of diode checks for a person with a scope is this, but it tells nothing about a diode's high voltage performance.

arrangement works on the same principle as the more complex instruments mentioned above. It is interesting, and very simple. It makes an excellent diode rejector; any diode which doesn't pass this test should quickly be thrown away. Incidentally, silicon diodes seem to have sharper knees and straighter traces than germanium ones.

Another and even simpler, gadget that quickly tells whether a diode is hopeless, is shown in **Fig. 113.** It is also identifies the diode's cathode (if it has one). The principle of this one should be obvious if you've been paying attention. Use low current lamps to avoid cooking small diodes. Operation is very simple. Connect the diode. If lamp A lights, the diode is good. If B lights, the diode is good, but you've got it in backwards or the diode is mismarked. If both A and B light the diode is shorted. If neither lights, the diode is open.

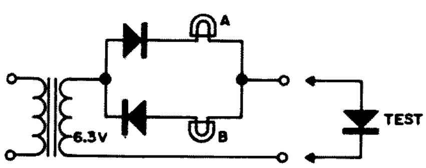


Fig. 113. This simple device gives a quick check of diodes. If lamp A lights, the diode is good. If B lights, the diode is good, but connected backwards. If neither lamp lights, the diode is open, and if both light, it is shorted.

A simple way to check diodes is with an ohmmeter, and a simple ohmmeter is shown in **Fig. 114.** If the diode is connected with its cathode to the positive terminal of the ohmmeter (reverse biased), no current flows (or at least very very little). Conversely, if the diode is connected with its anode to the positive voltage (forward biased), lots of current will flow. In simpler terms, the diode should have low resistance with the ohmmeter leads connected in one way, and high resistance if the leads are reversed. Almost any ohmmeter is usable. Be careful that your ohmmeter doesn't furnish enough current to damage the diode.

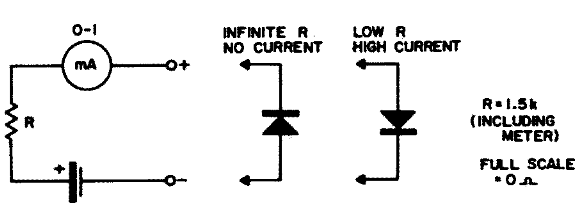


Fig. 114. This simple ohmmeter demonstrates how a diode can be checked with an ohmmeter.

An easy way to check zener diodes (incidentally, snobs call them **zayners** not **zeeners**) is shown in **Fig. 115.** Start with zero voltage, and increase it until the voltmeter stops rising. That's the zener voltage. If the voltmeter stops at about ¼ volt, you have a forward-biased germanium diode, and if it stops at about ¾ volt, it's a forward-biased silicon diode, instead of a reversed biased zener. Turn it around. It's a good idea to place a milliammeter in series with the diode to make sure that you don't exceed the power the zener can dissipate. You can figure the power input by Ohm's Law; power in watts equals voltage across the zener times the current flowing through it in am-

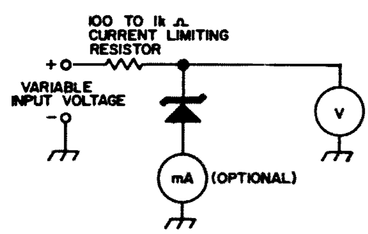


Fig. 115. Here's a simple way to find the breakdown voltage of zener diode.

peres. For example, if a 10-volt zener has 10 mA (0.01 amps) flowing through it, the power being dissipated by the zener is 1/10 watt (100 mW), which isn't likely to cook it. Most of the small glass zeners are rated at 250 or 400 mW, the small metal cased ones 1 W and the studs (with heat sinks) 10 W. There's no need to push the ratings when you check the zener break, though. Diodes have almost the same zener point with maximum dissipation and 1/10 dissipation.

You can check varicaps and varactors by the above methods, but that just tells whether they're diodes. You can also check them in practical circuits, or simplified test jigs. For instance, if you want to find a good frequency multiplier, make a multiplier and try diodes until you find a satisfactory one.

Transistors can be thought of as two diodes (emitter-base and base-collector), so you can check them for use as diodes by ignoring the unused lead. Silicon transistor emitter-base junctions often make excellent zeners, for example, while old germanium VHF transistor base-collector junctions can make good varactors, and old germanium power transistors make good low voltage rectifiers. Though it's a bit out of the scope of this article, you can even cut off the top of a transistor case and get a photocell.

. . . WA1CCH

RTTY In Holland and Belgium

In the last 18 months RTTY has been becoming popular in Holland and Belgium. For many years we have been reading about the activities of the American stations, but we couldn't get the machines. So RTTY was abacadabra to us. There were about four machines in Holland and they were very thick with dust! It is not so nice to work only with the same few stations! And, until two years ago, RTTY was not permitted in Belgium.

Moreover, here in Holland, we have different licenses. First, a general license for all the bands, and a C license for 144 MHz and up. When you have a C license and a machine, you have to wait until the right conditions to work. England, for instance. Even in England there are very few hams who work RTTY on two! Until two years ago Belgium didn't give a license for RTTY at all, and in Germany there are no 2-meter RTTY hams. Also, none in Denmark.

Toward the end of 1964, on the Belgium market, we began to get Creed machines, and that was the beginning of the Dutch RTTY enthusiasm.

We started the Dutch RTTY Gang with PAØAA, YZ, TED, CR, CPD, XW and VDZ, who had machines and were at the first meeting. Every month the Dutch RTTY hams have a meeting now in the center of Holland, at Woerden. In the summer months about 30 amateurs come to our meetings from all parts of the Netherlands. In Holland we have a total of 60 RTTY amateurs; in Belgium, about 40 or 50.

For years PAØAA has been sending a RTTY Bulletin weekly on Fridays (on 80, 20, and 2 meters). Recently ON4VB started a RTTY Bulletin on Sundays on 80 and 2 meters. While there was interest growing, more machines were becoming available. Practically all of the machines were from Creed (England) and Lorenz (Germany).

Our group was interested in buying a great number of machines together, but for a large party you need a lot of money!!

So, our members who didn't yet have a machine took a share of about $40 and some weeks ago we bought 27 Teletype printers, tables and rectifiers. We now have TT-14 perforators, TT-15 machines with and without perforators, etc.

The machines (from Germany) arrived in Rotterdam. We took a transport-car and transported the load to Leiden. The Dutch RTTY-managers PAØYZ and PAØVDZ controlled the gear and put it in working order. So we provided 60 hams with printers, and most of them work on two meters! Every RTTY'er gets a special license from our Government Post Office. Lectures were held about TU's, auto-start, basic principles, and so on.

Many of the Dutch and Belgium RTTY stations use the famous printed-circuit 5R6 TU (from DL6EQ). From the same manufacturer, we have the tone coils, the band-pass-filter, and the indicator.

We have the intention to use a clover leaf antenna for auto-start. A model is made by a local manufacturer and, after our tests, it will be made in series.

For two meters, for auto-start and call frequency, we have chosen 145.800 MHz. Crystals were exactly ground by a manufacturer to that frequency. In general we use the CCIT norm, that is 50 Bauds.

In the future we hope that the RTTY amateurs in Holland will have a VHF receiver on the frequency of 145.800 24 hours a day. By using a dial, such as is used in a telephone, you can make a selection of tones and you choose one or more amateurs, for whom you have a message.

All above is what the Dutch RTTY Gang will accomplish. We get publicity by writing articles in the Dutch Amateur Magazines (*CQ-PA*, weekly, and *Electron*, monthly) and we can say that "RTTY is in".

Since the Belgian Government began giving licenses, the Belgian RTTYers have also become active. At the end of 1965 and the beginning of 1966 two meetings were held in Brussels in the national shack of the UBA. ON4VY did much to get the Belgian gang active; ON5AJ is the Belgian RTTY manager.

It is now possible for the American amateurs (and the rest of the world) to make RTTY QSO's with Dutch and Belgian amateurs!

. . . PAØVDZ/ON8NC

Ed Marriner W6BLZ
528 Colima Street
La Jolla, California

The Wolverine

This transmitter is a 6AG7 crystal oscillator driving a 6146 on the 160-80-40-20-15 and ten-meter amateur bands, CW only. The editor will probably look askance at publishing this old circuit, but it does have advantages; it is a cheap, simple CW rig that satisfies all CW operation. A VFO can be plugged into the crystal socket when used at the home station. The rig is useful for that once a year 160-meter CW contest, or for the summer vacation trip, and it is worth having around the shack for a spare rig.

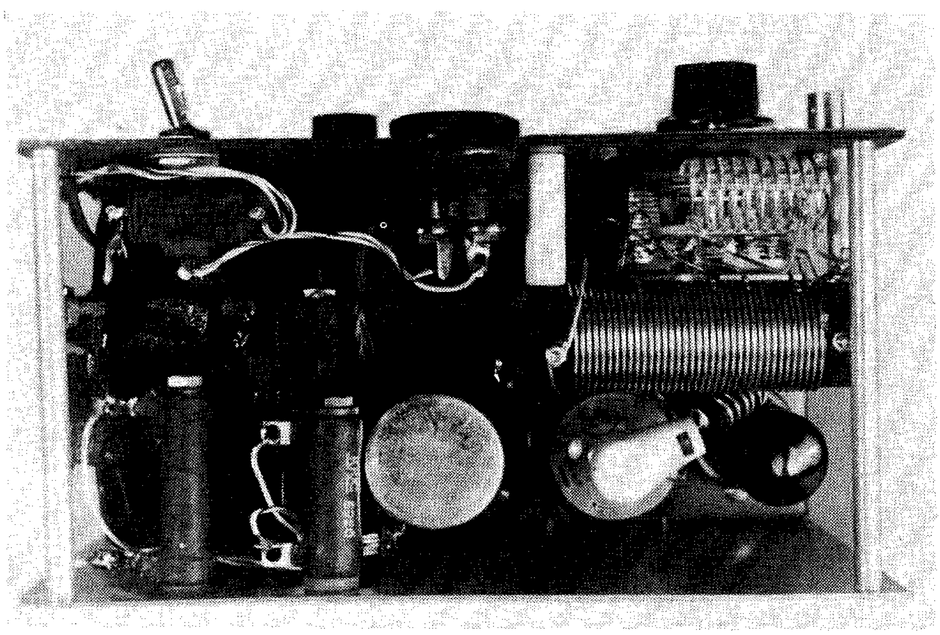
This transmitter is no toy, it runs 150 mA at 750 volts using a 6146 in the final, and a 6146B could be plugged in and the power increased beyond the 100-watt input limit. The set will work straight through on any crystal frequency, or the plate of the crystal oscillator can be tuned to a higher frequency band. With a 7 MHz crystal, the plate can be tuned to the 20-, 15-, or 10-meter bands, and by adjusting the screen voltage on the oscillator, the drive can be controlled for proper excitation to the 6146 tube.

"Old Fashioned?", Let me point out the tubes are *cheap*, and the 6AG7 has a metal shield. Also, the old octal sockets lend themselves to easy mounting of parts. If the rig is put together with lock washers it will handle any shock and vibration test given it when bouncing around in the back of the car. Foreign readers will especially welcome a circuit in which the parts are obtainable.

Theory

To be redundant, the 6AG7 crystal oscillator drives the 6146 amplifier which has been biased to cut-off for protection of the 6146 if the crystal stops functioning for some reason. This cut-off point was selected as −75 volts dc bias which is more bias than class AB-1 and less than class C. This may sound strange, but the crystal oscillator output is hard to control to keep it below the point where it would not drive the 6146 into grid current when it was class AB-1, and by using less bias than class C allows adjustment of the grid voltage between 2-5 mA reducing harmonics. Class-C operation is biased way beyond cut-off and is often a generator of TVI.

Advantage was taken of bridge rectifying a small receiver power transformer to ob-



Top view of the Wolverine transmitter. The 6146 power amplifier and 6AG7 crystal oscillator are on the left; the power supply to the right.

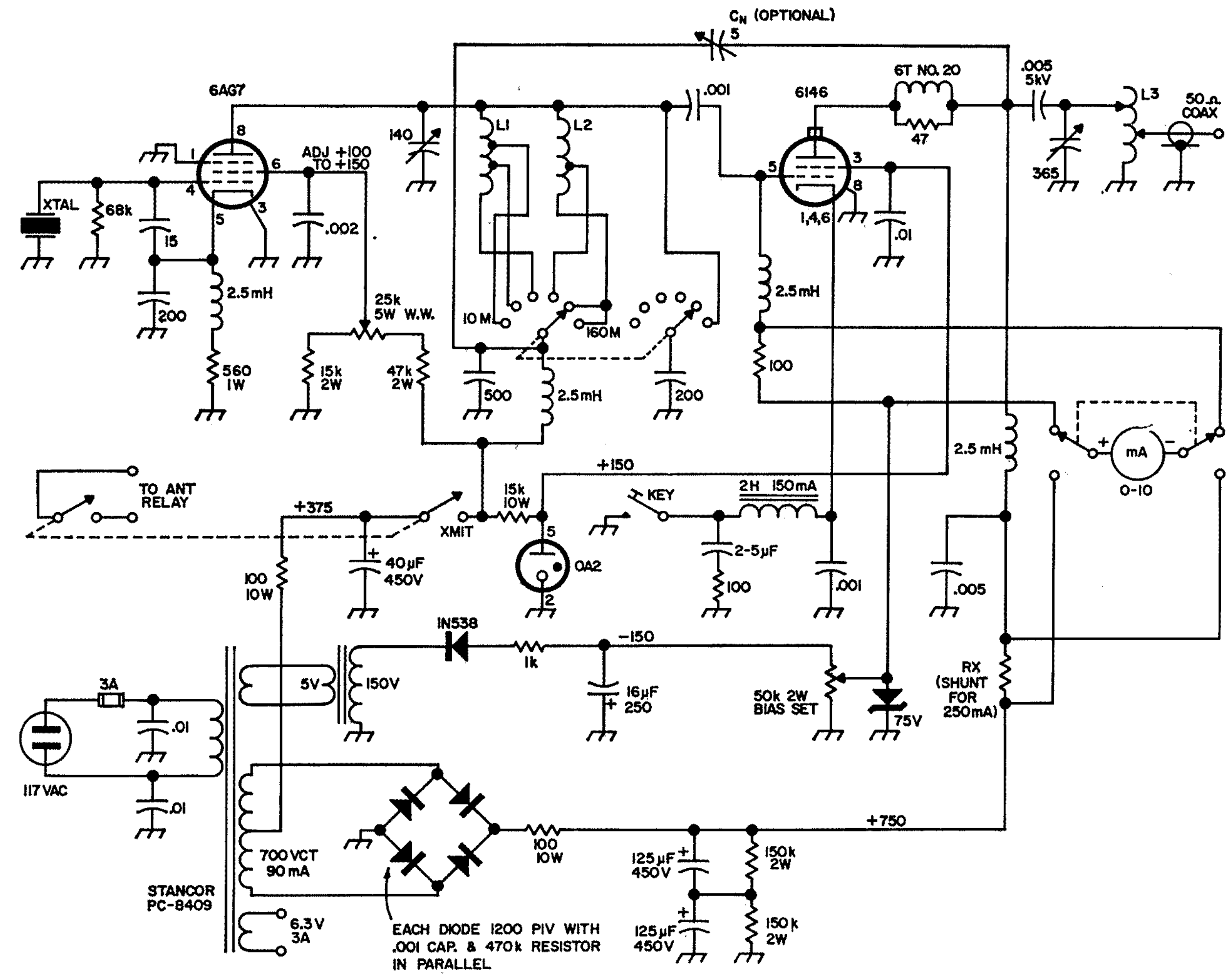


Fig. 1. Schematic diagram of the Wolverine transmitter for 160 through 10 meters. Coil data is given in Table 1.

tain 750 volts and keep the rig small. This could be done because of the low duty cycle operating CW, and the 90 mA transformer over-loaded for short keying periods does not heat too much. The supply voltage remains almost at peak values during keying because of the high value of filter capacitors and the use of a resistor instead of a filter choke. During sending periods the toggle switch turns on the crystal oscillator voltage with one half of the switch, and the other half turns on the antenna relay. The cathode of the 6146 is keyed while the crystal oscillator runs full time during keying; this makes a good sounding CW signal, and there is less chance of frequency shift and chirpy signals which might occur if the oscillator were keyed. There is no need to fear clicky signals using cathode keying because the clicks can be eliminated by using a 2-henry filter choke in series with the cathode and key to ground. A 100-ohm resistor and a 5-μF filter capacitor in series across the key will round off the keying pulse. Any oil-filled capacitor, 2 to 5 μF will be satisfactory. If larger values of capacitance are used, the signal sounds too much like primary keying and very soft. The lead going to the key should be RG-17/U coaxial line with the braid grounded to cut down on any radiation. The rig will be TVI proof if it is built into a sealed metal box. This rig has been used on all bands with no trouble.

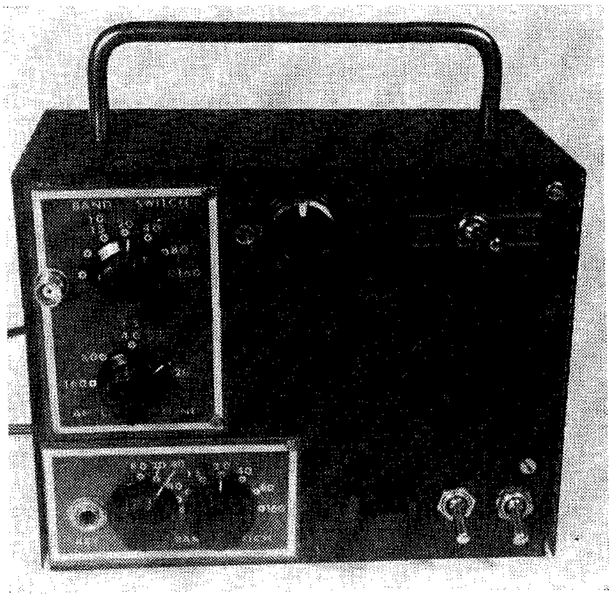
Construction

The transmitter is built on a California chassis number A-147 which is 4 x 8 x 2 inches. A Novice constructor would do well to use a larger chassis and spread the parts out. It is suggested that the crystal oscillator be constructed first and checked out on all bands. The crystal socket is mounted on the back of the cabinet and was a two crystal socket sawed in half so the crystal mounts vertically. The plate coil of the crystal oscillator is shorted out from the bottom end of the coil which moves the

supply lead up on the coil as the higher bands are used. The higher bands are at the top of the coil, and the slug is half way screwed in the form. A grid-dip oscillator will be handy in adjusting the proper number of turns for the various bands. The 20-, 15-, 10-meter bands use a piece of Air-Dux bulk coil rather than the XR-50 on which the 160-80-40 meter coil is wound.

When the crystal oscillator is finished it should be checked very carefully and the plate dial calibrated for the various bands using a grid dipper in the diode position. It is possible to cover several bands while tuning the capacitor to resonance, but the value of the coil can be adjusted so that it only tunes the one band.

The tank coil for the final amplifier was wound on a micarta tube found in a surplus store and was grooved, although Air-Dux coil stock can be used. However, this coil is held together with plastic and might melt with the extreme heat and if at all possible a ceramic or fibre form should be used. The 10-15 meter coil is Air-Dux and of such small diameter the heat does no harm. For coil switching a double-pole PA type Centralab ceramic switch was used to switch bands. One half of the switch was used to change the band tap while the other half changed to 50-ohm output tap point. This output tap is rather unusual but it is fool proof. The proper point was found by tuning the rig up on any one band and adjusting the tap for maximum output into a 50-ohm carbon resistor. A field strength meter was placed alongside the resistor and a clip was worked back and forth along the coil until a point of maximum output was reached. The output circuit is more stable than a pi-network for a simple rig because the load is on the tube at all times more or less constant, and there is less possibility of the 6146 taking off on its own when the impedance is changed. The tapped coil arrangement works well either into a dipole antenna direct, or into a link-coupled antenna coil. The drive control adjustment on the crystal oscillator will correct the grid current flowing in the 6146 grid to the proper value between 2-5 mA and prevent overdriving the tube. On the higher bands the output of the oscillator falls off and the output can be increased by adjusting this control to increase the screen voltage so that enough output is obtained to drive the 6146 tube.



The Wolverine transmitter—a low-power CW rig with a lot of bite.

Table 1. Coil data for the Wolverine transmitter.

L1—160 and 80 meters, National XR-50 coil form wound full with #28 enameled wire. 40-meter tap 3/8" down from top.

L2—17 turns of Air-Dux 516. 20 meters tapped at top, 15-meter tap at 9 turns, 10-meter tap at 5 turns.

L3—38 turns no. 18, 1" diameter, 18 turns per inch. 160 meters, plate tap at 38 turns, antenna tap at 7 turns; 80 meters, plate tap at 27 turns, antenna tap at 4 turns; 40 meters, plate tap at 16 turns, antenna tap at 2 turns; 20 meters, plate tap at 11 turns, antenna tap at 1 turn. 10 and 15 meter coil consists of 7 turns Air-Dux 508, plate tap at 7 turns, antenna tap at 1 turn.

Tuning

Plug in the desired crystal and turn the crystal switch on. Peak the crystal plate tank for maximum drive while watching the 0-10 mA grid meter. You could use a neon bulb. Adjust the screen drive for 2-4 mA drive, while the key is pressed. For a grid current reading the cathode of the 6146 has to be grounded. Next adjust the final tank tuning condenser for maximum output by watching your SWR meter or FS meter rather than the plate meter in the supply of the 6146. The rig should load up to 150 mA for operation.

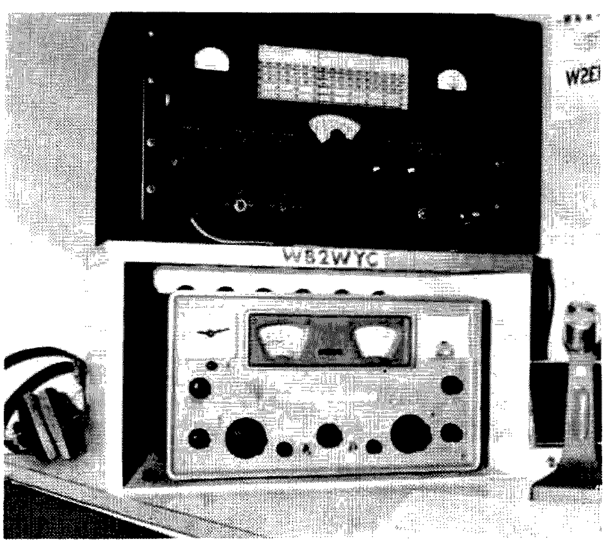
. . . W6BLZ

A Homebrew Operating Desk

Overall view of desk. Top is covered with linoleum, with anodized aluminum trim. The wood is painted cream, with a dark brown door. Complementary knobs and drawer pull from Sears, Roebuck.

I just finished reading Bob Leffert's article, "The Basic Desk", in your magazine. His design is good, and the article well written. I'm sure we all have our pet desk designs, to fit our particular needs. Let me toss in my two cents, for what it's worth, 'cause I've got a desk design too!

Low cost, limited building time, simple, attractive and portability were the goals to achieve. The inclosed photos tell the story of construction, design and finishes.



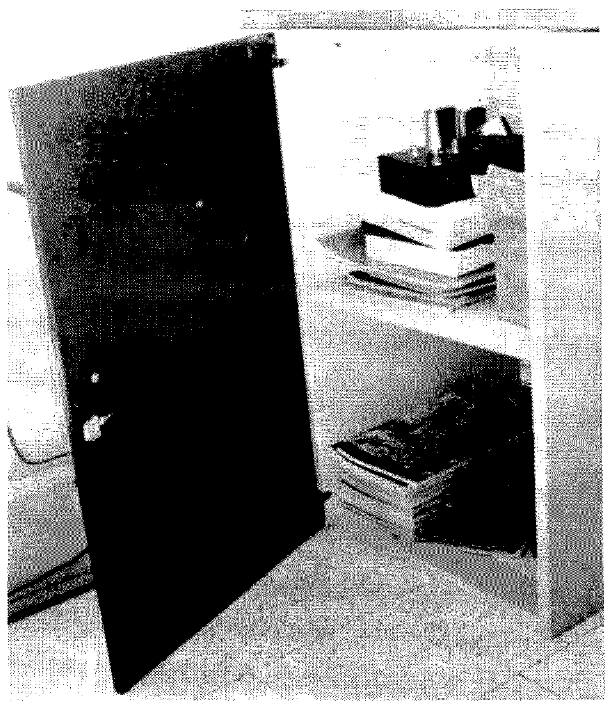
The cabinet built as an accessory to stretch desk top space. The back is ventillated by punching large (1") holes in the masonite. This cabinet is not bolted to the desk in any way, and can be shifted around at will.

Some side comments are in order. The entire affair, including paint, linoleum covering for the top, and aluminum trim around the top, came to just under $15.00. Time to design, build, finish, and final-assemble at the shack site, took three weeks of evening work; off and on. (I would estimate about 12 hours all together.)

I stretched my desk-top space, as you can see from the photos, by use of a wooden cabinet. The cabinet is not screwed down to the desk, and can be moved or removed at any time. It is a real space saver, and helps group all operating controls in one area. The back of the cabinet is ¼" masonite, drilled out with 1" holes to allow adequate air flow around the receiver.

All the goals stated above were met. I've been sitting at this desk for over a year, with no nagging desires to change the design. Besides, I have a piece of furniture that my wife is not ashamed to show to visitors; to me, the greatest compliment of them all!

. . . Bud Michaels, WB2WYO
Mendon, N. Y. 14506



The cabinet is made to accomodate 19" wide rack panels, if so desired. Thus, a power supply, or linear could be easily built in. In my case, I have two shelves for odds-n-ends. Door is held in place with "hidden" hinges, and a magnetic latch.

Don Marquardt K9SOA
RR 7, Box 436
Crown Point, Indiana 46307

A Simple and Inexpensive Cavity for Six Meters

Here is a simple capacitively loaded coaxial cavity for use on six meters. It should help reduce TVI caused by harmonics of your crystal oscillator which fall in TV channels. I won't go into the theory of cavities at this time, but will just say that the cavity described here, has been in operation for some time and it works very well. As you can see, the cost is very low, with the coax connectors and trimmer being the most expensive parts.

While I'm not a coffee drinker, myself, I was able to scrounge up a couple of empty cans from my neighbors who were more than glad to donate something for a project which would help them enjoy channel 2 again.

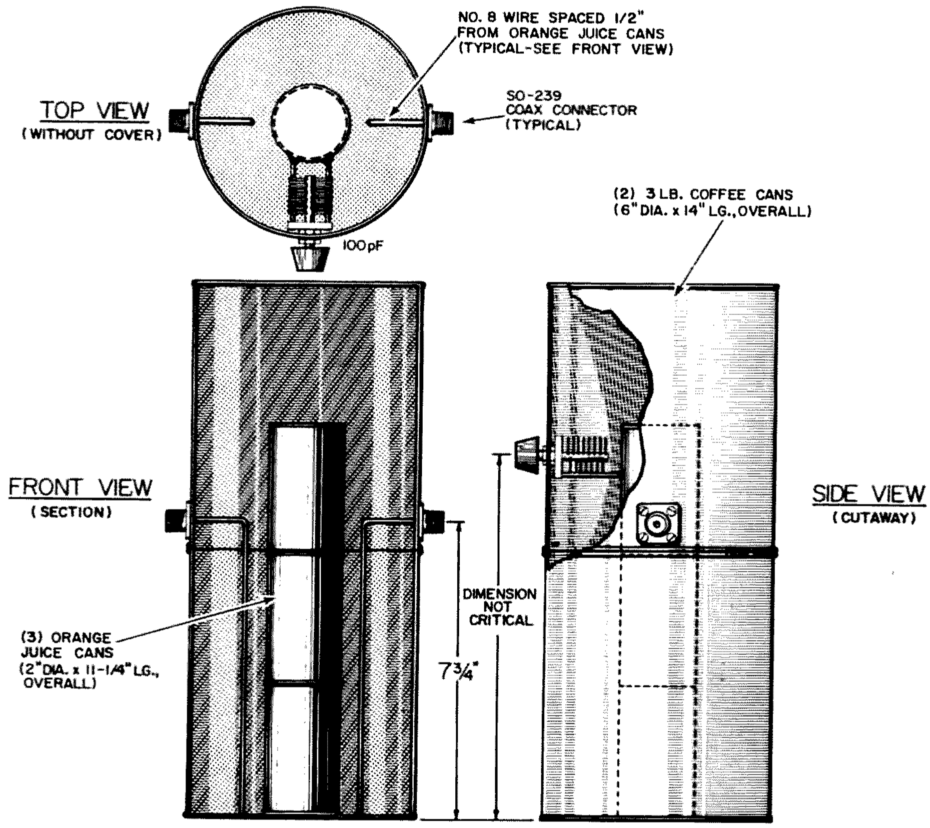
All the parts, including the coax connectors, were soldered together so that the entire unit was sealed. Be sure when you get the small cans, that they are steel. Most of the cans are made of aluminum, which makes it difficult to solder. The top and bottom plates were made from flashing copper, but can be of tin or any other fairly rigid material so the inside will not move.

I found that the setting of the capacitor was pretty critical on this particular unit, and had to be reset when moving up or down the band.

If you wish, the entire unit can be made out of copper and then silverplated. It will help, but not enough to warrant the extra time, trouble, or expense . . . unless you like things nice and fancy.

. . . K9SOA

A low-cost cavity for six meters made from two three-pound coffee cans and three orange-juice cans.



Assignment of Two Letter Call Signs to Amateur Extra Class Licensees

The FCC has amended the amateur rules, effective November 22, 1967, to provide for the assignment of two letter calls (call signs with a single letter prefix and a two letter suffix) to applicants holding an Amateur Extra Class Operator license and who held any amateur operator license issued by the Commission, or by one of its predecessor agencies, 25 years or more prior to the receipt date of an application for such assignment. This provision is in addition to that which permits the assignment of such calls to previous holders of two letter calls.

Applications for two letter calls may be filed on or after November 22, 1967 as follows:

1. Complete FCC form 610 indicating that the application is for a two letter call.
2. Attach current amateur extra class license (or photo copy thereof) in the space provided.
3. Furnish evidence that an amateur operator license issued by the Commission, or by one of its predecessor agencies, was held 25 years or more prior to the date the application is received by the Commission. Such evidence may be an expired license, the call sign and date such a license was held, if the license is not available; or any evidence of eligibility which can be verified by the Commission.
4. Mail check or money order in the amount of $20.00 payable to the Federal Communications Commission with form 610 to Federal Communications Commission, Gettysburg, Pennsylvania 17325. If modification or renewal is also requested the filing fee is $22.00 or $24.00 respectively.

Requests for specific call signs will not be honored. Present holders of two letter call signs will not be assigned an additional two letter call, and only one two letter call will be assigned to licensees made eligible by this rule amendment. ■

1968 YL/OM Contest

All licensed amateur operators throughout the world are invited to participate in the 1968 YL/OM contest. This is a "fun" contest where the YLs get out in force to let the men get acquainted with them. The contest runs for 24 hours, so it is fairly easy. All bands may be used but a station may be contacted only once during the contest. The phone section of the contest will begin February 24, 1968 at 1800 GMT, and will end February 25 at 1800 GMT. The CW section will start March 9 at 1800 GMT and end March 10 at 1800 GMT.

The procedure is for the men to call "CQ YL" and the gals call "CQ OM". Exchange must include QSO number, signal report, and your ARRL Section, or country if you are not in an ARRL Section.

Scoring

A. Phone and CW contacts will be scored separately. Submit separate logs for each contest.

B. One point is earned for each station worked.

C. Multiply the number of contacts by the number of different ARRL sections (or countries) worked.

D. Contestants running 150 watts input or less at all times during the contest may multiply their final score by 1.25 (low power multiplier). This multiplier applies to SSB stations using less than 300 watts PEP.

Logs

Copies of all logs, showing claimed scores, and signed by the operator, must be postmarked no later than March 21, 1968 and received no later than April 9, 1968 to be eligible. Send copies of logs to Claire E. Bardon W4TVT, 2238 Morgan Lane, Dunn Loring, Virginia 22027.

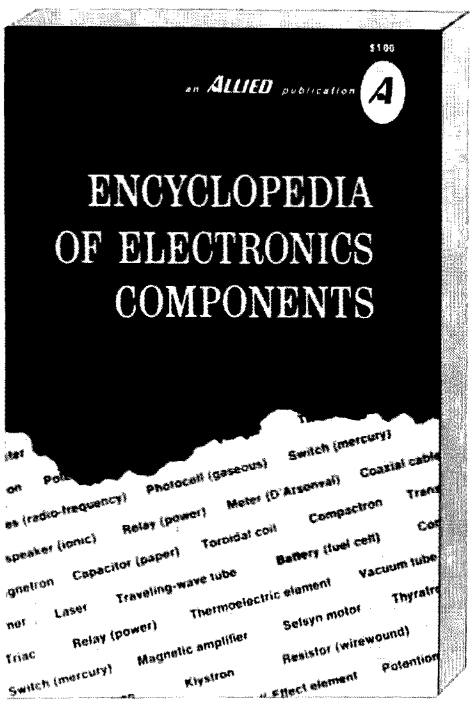
A gold cup will be awarded to the first place YL and OM in each contest. The winner of a phone cup is also eligible for the CW cup. Certificates will be awarded to the high score winner from each district of the U.S. and Canada, and to the winner from each country.

No logs will be returned and copies must be legible.

. . . WØHJL

New Books

Encyclopedia of Electronics Components



The new *Encyclopedia of Electronics Components* from Allied Radio alphabetically lists, describes and illustrates all of the basic electronics components currently in use. Edited by Dr. Alva Todd, Professor of Electrical Engineering at the Illinois Institute of Technology, this book is virtually an electronic text that provides an understanding of the individual units used in electronics devices and systems in one reading.

The material is put together in a very readable form, and the descriptions are in non-technical language. Each components is clearly identified, its use is carefully explained and any special handling or installation requirements are carefully covered. All in all, it is a handy reference for anyone in electronics, even the old time ham; it is of particular interest to students, novices and experimenters. $1.00 postpaid in the U.S.A. from the Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680.

New Books From Sams

ABC's of Vacuum Tubes, by Donald A. Smith, is an introductory book presenting the basic understanding of vacuum-tube theory. No study of electronics and modern circuitry is complete without a good understanding of the electron tube. Catalog No. 20576 List Price $2.25.

Walkie-Talkie Handbook, by Leo G. Sands, describes the various types of walkie-talkies now on the market—including both licensed and unlicensed types. It covers the circuitry, accessories, specifications, maintenance and the licensing required. In addition it covers Part 95 of FCC Rules and Regulations covering the Citizen's Band. Catalog No. 20572 List Price $3.95.

Lasers and Masers, by Charles A. Pike, describes the basic operating principles underlying all lasers and masers. Questions and answers are included at the end of each topic to assist in study and review. Catalog No. 20559 List Price $495.

Servicing Closed-Circuit Television, by Melvin Whitmer, introduces the technician to the operation and maintenance of closed-circuit TV systems. It gives a large amount of service information previously available only from TV manufacturers. Catalog No. 20574 List Price $4.25.

Controlled Guidance Systems, by Hal Hellman, is a new programmed text covering the fundamentals of guidance systems. It encompasses such areas as ballistic trajectory, hyperbolic guidance, motion, translation, proportional navigation, and construction of various systems. Catalog No. 20573 List Price $4.95.

ABC'S of Hi-Fi and Stereo, by Hans Fantel, presents that needed information in an informal, non-technical manner in this revised edition of an old favorite. It discusses in detail the requirements of amplifiers, turntables, tone arms, cartridges, tuners, speakers, and tape recorders. Catalog No. 20539 List Price $2.25.

CB Radio Antennas, by Dave Hicks, points out the vital necessity for a good antenna system in CB due to the power restrictions. Included are discussions on the characteristics of radio waves and how they affect the design of an antenna, what communicating ranges to expect, base and mobile installations, methods of improving present systems, and maintenance. Catalog No. 20567 List Price $3.25.

Measuring Hi-Fi- Amplifiers, by Mannie Horowitz. Both vacuum tube and transistor amplifiers are covered extensively. It discusses in detail the checking of frequency response, harmonic and inter-modulation distortion, sensitivity and overload, measuring and matching phono, tape playback, and microphone equalization curves. Catalog No. 20561 List Price $3.25.

Tape Recording for the Hobbyist, by Art Zuckerman, tells not only what you can do with a tape recorder, but how to do it. While dealing mainly with tape recordings as a hobby, this book gives many ideas for more serious uses of recorders in the home and office. It covers special sound effects, candid recordings, party tricks, "detective type" work, and also describes home video tape recording methods. Catalog No. 20583 List Price $3.25.

A new *ABC Beginners Library* series of technical books has been introduced by Howard W. Sams & Co., Inc.

Each 5-book set is a complete library for students and beginners in one of three popular areas of electronics: Electricity/electronics, Computers and Semiconductors, and Communications.

Titles available in *ABC's of Electricity/Electronics* Catalog No. 20577, sets are:

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ABC's of Electricity	#20263
ABC's of Antennas	#20010

Titles in *ABC's of Computers & Semiconductors* 20578, are:

ABC's of Computers	#20012
ABC's of Computer Programming	#20123
ABC's of Boolean Algebra	#20055
ABC's of Transistors	#20440
ABC's of Varactors	#20508

Titles available in ABC's of Communications 20579 are:

ABC's of Radar	#20014
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ABC's of Ham Radio	#20213
ABC's of Lasers and Masers	#20262
ABC's of Short Wave Listening	# 20554

Each 5-book set is packaged in a handsome slipcase and retails at $9.95 a set, a considerable savings over the individual book prices.

Look for these Sams books at your electronics distributor, or write directly to Howard W. Sams & Company, Inc., 4300 West 62nd Street, Indianapolis, Indiana 46206.

New Books From Editors and Engineers, Ltd.

Ten new Skilfact electronics books have just been released which provide useful information for anyone interested in learning about the many facets of the rapidly expanding field of electronics. These 96 page paperbacks sell for $1.00 each.

Introduction to Basic Electronics, by Louis M. Dezettel, explains the fundamental concepts of electronics from the structure of matter to the action of electrons. It also provides a basic understanding of the vacuum tube, transistor, and other components showing how they are used in electronics work.

Fundamentals of Transistors, by Louis M. Dezettel, can be useful in the repair of home electronic equipment. This book presents a simplified explanation of transistors that may be understood without more than a basic knowledge of general electronics.

Basic Electronics Circuits, by Farl J. Walters, explains the theory; operation, and primary application of the basic electronic circuits. This book tends to take the reader a step further into the world of electronics and to serve as a review and reference for readers with more experience.

Electricity/Electronics Science Projects, by Edward M. Noll, teaches the reader about electricity, electrical current, and what comprises an electrical or electronic circuit. Both ac and dc electricity are covered and their operations demonstrated. Practical skills are developed in assembling and testing by constructing various experimental units.

Television: How it Works, by Len Buckwalter, presents a general view of the basic function of television systems—how they convert light and sound into electrical signals, transmit them through the air, and convert them back into light again.

Electric Motors and Generators, by Allan Lytel, is a basic introduction to motors and generators. The book explains what they are, how they operate, and what they can be expected to accomplish. Included are simplified explanations of the various types of motors and generators. This book is a good guide for either the technician or the layman.

Computer Programming Fundamentals, by Lawrence Buckmaster and Allan Lytel is ideal for anyone interested in understanding computer programming as a field of employment or wishes to have a handy source of reference for general information.

Picture Guide to TV Troubles, by the technical staff of Editors and Engineers, is an easy, methodical guide to the repair of television receivers. This book explains through the use of tube displays, how a fault can be readily isolated and corrected.

Easy To Build Ham Radio Projects, by Charles Caringella W6NJV, is an exciting book for ham radio enthusiasts and contains construction projects for the beginner as well as the advanced amateur.

Electronic Test Equipment, by Louis M. Dezettel, is written for the technician, the experimenter in electronics, or the man who likes to build his own electronic circuits both for fun and to expand his knowledge of the science. He introduces the basic test and measuring equipment needed for fundamental circuit exploration.

All of the above books are available from Editors and Engineers, Ltd., Post Office Box 68003, New Augusta, Indiana 46268.

73 on Microfilm

Interested in looking back through the previous issues of 73 *Magazine*? How about those scarce issues that are no longer available? If you want to keep a permanent record of outstand amateur radio articles, the answer is in the new microfilm edition of 73 which will be available shortly. Write to University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, Michigan 48106 for further information.

What's New for You?

Have you found a simple new circuit, or new semiconductor or other component, that has been useful in your building? There are plenty of hams who would like to find out about it. Why not send in a short note for this column and we'll publicize it and make it available to all the other experimenters who read 73. We're also looking for technical comments on 73 articles—corrections, modifications, or compliments—and newly available surplus, technical nets and meetings, new records and other information that's likely to be interesting to the technically-minded ham. Please keep the comments short, and send them soon before someone beats you. Send to Paul Franson WA1CCH, "What's New for You?", c/o *73 Magazine*, Peterborough, N. H. 03458.

Where Do You Get an EL229?

In Frank Jones' (W6AJF) article in January on improving his transistor converters, he mentions an excellent Motorola transistor, the EL229. Edward Randall now tells us that this transistor is available from Motorola distributors as the MPS6542 for about $1.20. This transistor is in a plastic case. Edward also suggests some possible replacement titles for *What's New?*: Scatter Patter, Ham Hot Line, Ama News, Techni-Notes, Ethofone (?) and Tek Tock.

70 cm Surplus Coming?

Kent Mitchell, W3WTO, sent a note he clipped from the USAF Communications-Electronics Doctrine Newsletter, stating that the SCR-718 radio altimeter, which operates in the 420-460 MHz range, will be prohibited from use in the U.S. after February 15, 1968. Perhaps these units will start appearing in surplus in not too long.

More Gain for the SB-100?

In the May *What's New*, there appeared a note suggesting that changing the value of a resistor in the SB-100 increases the gain of the unit. At least two readers K2RDM and WNØRAC checked this with the Heath Company about this modifioation, and Heath doesn't recommend it. Here's a quotation from their letter to WNØRAC: We do not recommend the change of resistor R221 from 470 ohms to 47 ohms. The reason for this being that this is a load in isolation resistor for the LMO. It is true that the reduction of resistance increases the injection voltage to the various mixer stages. However, a side problem that does occur occasionally is the shift between transmit and receive frequencies of the LMO. The actual frequency shift in some cases has been measured to be as much as one kilocycle. However, in many other cases it does not shift at all. Thus you will have to check on your own to verify whether or not the condition is apparent.

The Great Dipper

In the schematic of WAØAYP's "Great Dipper" in the August issue, the 1 k emitter resistor to the 2N2398/2N918 oscillator stage should be returned to the nine-volt supply, *not* to the junction of the 39k resistor and .02 μF capacitor. The pictorial diagram is ok. Thanks go to WB2UMH for finding this one.

$2.00 200-watt Dummy Load

The author of the 200-watt dummy load article in the May issue, W2OLU, wrote in to tell us that he had been informed by one of our Australian readers that the resistors used in the load were capable of a short-time overload (5 seconds maximum) of ten times their rated wattage. The Australian should know what he's talking about since he's a sales engineer for Corning Glass, manufacturer of the resistors. The short-time overload will only result in a permanent resistance change of 1% or less. The CGW resistors are made of Pyrex glass, and coated with tin oxide at red heat. Maximum

"hot spot" temperature is 235 degrees Centigrade (about 450° F). With this information at hand, some enterprising ham will no doubt try to run 1 kW, ICAS, to the thing!

New GE Consumer IC's

General Electric has introduced three new inexpensive, plastic-cased linear integrated circuits designed for consumer use. They follow GE's 1-watt audio amplifier, the PA222, which was mentioned in this column a few months ago. The new IC's are the PA237, a 2-W audio amplifier (about $4), the PA189 70-dB gain amplifier-discriminator for the sound channel of TV sets or for FM receivers, and the PA230 general-purpose low-level audio amplifier. All come in small flat plastic packs.

$1 Phototransistor with Built-In Lens

Photocells and other light-sensitive devices aren't used much in ham equipment. Nevertheless, those of us who like to build and experiment are often interested in many of the gadgets that can be built with photocells: automatic lights, burglar alarms, TV commercial quieters, and many more. General Electric has recently introduced a new economy phototransistor (L14B) packaged in a clear epoxy case. The case is curved and acts as a lens, eliminating the expensive optics required for many photocell applications. This phototransistor can also be used as a standard photocell by ignoring one lead. This brings to mind the old trick of making your own phototransistor by cutting off the top of a metal-cased transistor. Unfortunately, this often leads to contamination, so the devices made in this way are often unreliable. A power transistor is best for this use.

The Ancient Marriner

Fig. 1. in the article on the Ancient Marriner (page 54, February issue) is correct. However, there is a reference to 6250 pF in the text, but this is a typographical error. Thanks to the Not-So-Ancient Marriner, W6BLZ.

Repairs to the Clegg 99er

After a few years of use, the vernier tuning shaft of the Clegg 99er tends to deteriorate. Factory replacement is expensive so I began looking for a less costly way to replace this part. I took a Lafayette tuning capacitor No. 32-C-0917 at $1.50 and a No. 32-C-0928 knob at 35c and made the replacement. The dial calibration comes out just about right with a little touching up of the dial calibration slug and one is right on frequency.

. . . Jim Hysan W1VYB

Silver Plating

If you are interested in silver plating that VHF tank circuit, or high-frequency linear amplifier tank coil, you should look into the silver-plating powder available from The Cool-Amp Company. Although this material has been mentioned a number of times in the past, we still get requests for their address.

This material comes in powder form and is very easy to use. All you have to do polish the item to be plated with a sharp steel wire brush or abrasive cloth, wipe clean and rub on the Cool-Amp silver-plating powder with a damp cloth. Then rinse the item thoroughly with clean water and wipe dry with a clean cloth. Presto—beautiful silver plate. A quarter pound of material costs $4.50, but this will do an awful lot of plating. Order from Cool-Amp Company, 8603 S.W. 17th Avenue, Portland, Oregon 97219.

Inexpensive Zener Diodes

If you're looking for an excellent, low-cost zener diode, you should investigate the new 1-watt zeners made by Schauer. These tiny (½-watt-resistor size) plastic-cased zeners sell for only 43¢ apiece in single quantity (20% tolerance). The 10% zeners are 50¢ and the 5% ones are 67¢. They are available in voltages from 2.4 to 16 volts, with type numbers SZ2.4 to SZ16.0. The minimum order from the factory (Schauer Manufacturing Company, 4500 Alpine Avenue, Cincinnati, Ohio 45242) is $10, but they'd be happy to send you more information and a list of distributors free.

Collins Switching Unit

It appears that part of the plugs in the diagram of W6EUV's article on page 82 of the July issue were mislabeled. Here are the corrections from W6EUV: "J2 as shown in the diagram should read J1 and J1 should read J2. The VFO Input label of J2 should be changed to VFO output."

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Bill Welsh W6DDB
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Burbank, California 91506

Novice Data

If you are thinking about getting the Novice license, or if you already have it, W6DDB has some excellent words of advice. Bill has taught hundreds of amateur licensing classes, so he knows what he's talking about.

This article provides helpful tips to those who are presently operating as Novices, and it will make things easier for those who are about to start their Novice operation. The author has helped thousands of people obtain their Novice, Technician, and General class tickets and has spent a lot of time helping students select their station equipment and get it set up. Despite the fact that each Novice believes his problems are unique, most problems are common and they can be avoided or overcome if the reader heeds the advice provided. This article is separated into three parts; (1) setting up the station, (2) operating the station, and (3) getting the General ticket.

Setting up the station

General

Location. Don't set up your station in a garage, cellar, or any other damp area. Long periods of relative inactivity, while exposed to cold or dampness, will eventually cause illness. Set up a neat station at some comfortable location in the heated/cooled portion of your home; there's no reason why a ham station should be so messy that it is not acceptable in the house.

AC power. It is best to power your station from a separate ac power line which you can fuse and control independently. If this is not readily accomplished, it is easy to install a fused ac strip connector on the rear of your operating table with its own on-off switch and indicator light. You will probably find it necessary to install noise filters to keep household electrical interference (from can openers, hair dryers, vacuum cleaners, etc.) out of your equipment.

Lighting. Don't install fluorescent lighting at your station because it will introduce a bothersome noise source which you should avoid.

Safety. Make sure there is no way children (or inquisitive adults) can come in contact with exposed voltages external to your equipment; make your station completely safe. The most common danger is exposed 115 Vac terminals on antenna change-over relays; tape over these terminals.

Antenna change-over. Make sure you set up your station for single-switch change-over between transmitting and receiving, including antenna change-over and receiver muting. There's no sense in having to throw two or more switches (plus adjusting receiver gain controls) each time one changes back and forth between transmit and receive.

Set up a neat station at some comfortable location in the heated/cooled portion of your home. Not in the garage or cellar.

Building. Don't use any of your Novice license term building ham gear. Building and experimentation are fascinating parts of ham radio but the Novice license term rushes by too quickly to permit one to do anything but operate and study to prepare for the General exam. If you plan to build any part of your Novice station, have it built and smoke-tested before you even pass your Novice 'written' exam. There's plenty of time to enjoy building and experimenting after you get your General ticket. Have your Novice station set up and ready to operate before your license arrives in the mail.

Used and new gear. Used equipment provides the best possible station at the lowest cost. An initial Novice station usually costs $150 to $750, complete. Don't make the mistake of assuming that all radio distributors recondition or check out used equipment before reselling it; sad experiences have taught us that most of them give used gear little more than a superficial inspection before putting it up for resale. If possible, purchase your used gear from a fellow ham, particularly if you are in a radio club. It is okay to listen to the advice of long-licensed hams in regard to what equipment is good for an initial station, but bear in mind that it is natural for them to recommend receivers and transmitters which performed well for them—and that may have been 10 to 50 years ago! Remember that such equipment is usually quite old and a lot of it has been superseded by units which are lighter, smaller, and more efficient on today's crowded Novice bands.

Receivers

Cost. Once you have determined the total amount you are going to spend on your initial station, set aside about two-thirds of the amount for the purchase of the best used receiver you can locate. Don't buy a junk or inadequate receiver with the intention of fixing it up; get the best unit you can find. A good used communication receiver costs from $100 to $250.

Selectivity. Selectivity is the receiver's ability to separate two or more stations when they are nearly on the same frequency; several receivers combine excellent selectivity with built-in adjustable rejection which lets you drop an unwanted strong interfering signal down below the level of a desired weaker signal. Check out selectivity and notch rejection on a crowded band.

Sensitivity. Sensitivity is the receiver's ability to detect weak signals and to produce usable audio output levels from them. Almost all receivers seem quite sensitive on the lower bands, so check the sensitivity on the higher bands (particularly 15 meters).

Electrical stability. If a receiver has good electrical stability, there will be very little frequency drift as it warms up. A simple check is to tune in a frequency standard station (such as WWV, on 2.5, 5, or 10 MHz) as soon as you turn on a cold receiver; after the receiver has run 5 minutes, check how much dial correction is needed from the original setting. Repeat the 5-minute checks until the receiver shows no detectable drift.

Mechanical stability. If a receiver has good mechanical stability, you can tune to a stable

signal (such as WWV) and touch the front panel controls (as necessary) without having the frequency change until you actually adjust the frequency or BFO control. Make this check after the receiver has warmed up and has reached electrical stability. A quick check can be run by just flicking your fingernail against various parts of the receiver's cabinet and control panel with the receiver set for maximum selectivity and tuned to a stable signal.

Crystal calibrator. A crystal calibrator in your receiver provides an inexpensive way to meet the FCC's requirement for a frequency measurement device of laboratory standard accuracy which is independent of one's transmitter frequency control. Most of the better receivers now include a 100-kHz crystal calibrator which you will find is worth its weight in gold.

Transmitters

CW-only rig. Purchase a transmitter which you plan to use just until you get your General ticket. There's no sense in purchasing big rigs which include high power, modulators, VFO's, and other goodies which will be useless to you on the Novice bands. The medium and high power AM/CW transmitters are a drag on the present market and they command very little resale value. Select a code-only 50 to 75 watt input rig for use in your Novice station; make sure it covers the 80, 40, and 15 meter Novice bands. Typical popular Novice transmitters include the Eico 720, WRL Globe Chief, and Johnson Adventurer.

Make your station completely safe. Tape over any exposed leads.

Crystals. There is no need to purchase a lot of crystals for each Novice band because a few rocks will cover each band very well. Typical popular trios of crystals for the 80, 40, and 15 meter Novice bands are: 3705, 3720, and 3735 kHz; 7160, 7175, and 7190 kHz; and 7036, 7043, and 7050 kHz (for tripling to 21.108, 21,129, and 21,150 kHz). Crystals within 2 kHz of the stated frequencies would be satisfactory; there's no reason to buy rocks exactly on the suggested frequencies.

Dummy loads. Don't assume that light bulb (and similar) transmitter loads don't radiate; they have been heard for more than a thousand miles. When you have your station hooked up and ready for a final checkout, don't test your rig into a dummy load or antenna before your ticket arrives; have a licensed friend check the rig out for you using his own call portable from your location. Make sure your station includes a good dummy load for test purposes; actual on-the-air testing should be minimized.

Transceivers

Novice requirements. It is a sad fact that there is very little equipment on the market which is specifically designed for Novices. Novices continue to be a prime market for radio equipment but most manufacturers have failed to produce the gear Novices need. A natural market for a top-quality transceiver is the Novice but none of the present units do the job completely; a Novice transceiver should include the following built-in features:

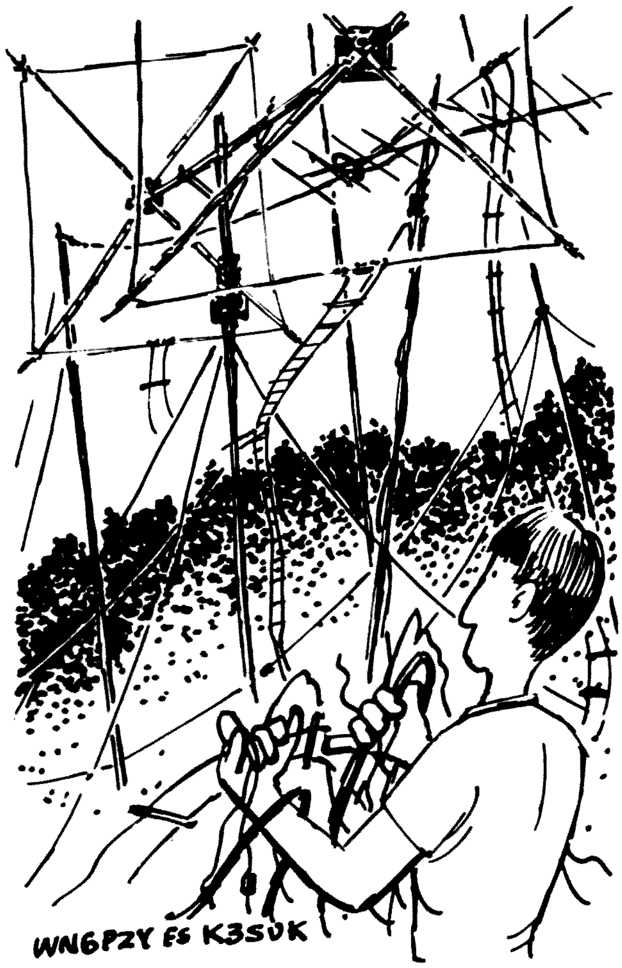
Excellent sensitivity, selectivity, stability, and rejection capability in the receiver.

WWV coverage on 5 MHz.

100-kHz and 10-kHz crystal calibrators

Code monitor/oscillator

Antenna coupler and VSWR meter



If possible, erect an antenna for each band you use and place them as high and clear of objects as possible.

Transmit-receive relay

Grid-block, break-in keying

75-watt, crystal-controlled, Novice-band-only transmitter covering 3.7-3.75, 7.15-7.2, and 21.1-21.25 MHz

Three internal crystal sockets for each band, with front-panel selection plus write-on material to permit each frequency to be pencilled on the front panel at the switch.

Low-pass filter in output, plus adequate filtering of AC and keying leads.

Switch-selectable metering which permits the final amplifier's input voltage and current (power) to be read directly; no idiot-type output meters.

Separate low- and high-voltage fuses and indicator lights, plus separate fusing of the final amplifier high voltage line.

Heavy-duty ground post.

No VFO, modulator, linear amplifier, or other accessories (or built-in units) which are not used by Novices.

Transmitter, receiver, power supply, antenna relay, etc. all in one stylish cabinet; no outboard accessories.

24-hour numechron-type clock with 10-minute warning buzzer.

All front panel controls tilted up to be directly in line with the operator's line of vision.

Excellent detailed manual which enables a Novice to completely understand how the unit works in addition to the setup, operation, adjustment, and repair procedures.

Antennas

Monoband. If possible, erect an antenna for each band and place each one where it is as high as possible and clear of surrounding objects, including the other antennas. If parts of antennas must come in close proximity to each other, try to have them at right angles to each other to minimize interference between them. Try to avoid having a leg of your antenna fold back on itself but (short of that), don't worry about it if your antenna runs all kinds of crazy angles.

Marconi and Hertz antennas. The quarter-wave (Marconi) and the half-wave (Hertz) antennas are particularly popular on 80 and 40 meters because they require very little 'flat top' space, since their 'feedline' and their 'flat top' are both part of the resonant antenna lengths. In addition, Marconi and Hertz antennas have no transmission lines and, hence, no transmission line losses. Both of these atennas require an excellent rf ground attached to the transmitter or more rf power can dissipate between the transmitter and ground than is radiated by the antenna.

Inverted Vee. The modified inverted Vee antenna is very popular on the 40-meter band. This antenna just requires that the center portion of the dipole be elevated as high as possible; the ends can be attached to lower points which are easily accessible. Most hams cut the legs a bit long and check the SWR each time as they trim the ends back evenly; careful pruning can produce an antenna which is resonant smack in the middle of the Novice band.

15 meters. Due to its more convenient (shorter) length, the 15-meter antenna presents fewer problems. If you can do it, you would do well to erect a rotatable directive an-

tenna (quad or beam) to provide the best possible results on this excellent band. There have been cases where Novices have worked more than 100 foreign countries on 15 meters; this is unusual, but it is common for a Novice to work 30 to 45 states and 15 to 40 countries on this band.

Harmonic and trap. The harmonic/trap antenna is more efficient than the extremely short mobile antennas, but they are not as good as individual full-length antennas for each band. If you plan to use a harmonic antenna, understand that you must be extremely careful to minimize the harmonic output from your transmitter because the antenna will accept and radiate any harmonic energy it receives.

Verticals. The verticals (including ground planes) offer low-band operation in a minimum of horizontal (flat-top) space. The ground plane offers low angle of radiation with respectable DX results. The verticals are quite susceptible to ignition interference, though, and proximity to heavy traffic can give one severe problems. Remember that the multiband vertical is not as efficient as a singleband vertical and it does present the danger of freely radiating harmonic output from a transmitter.

Mobile whips. Don't waste your time searching for a miracle antenna which will mount on your windowsill and provide efficient operation on all bands. No shortened antenna radiates your transmitters's output as efficiently as a fullsized antenna. To emphasize the inadequacy of mobile antennas and why you should avoid using them (except mobile), a check of a popular mobile antenna provided the following results on the 80-meter band:

Ohmic (loss) resistance	3.0 ohms
Radiation (useful) resistance	0.2 ohms
Efficiency	6%

To make you realize just how unacceptable this is, understand that you'd be tickling the ether with just 3.72 watts of radiated rf power if you ran a full Novice gallon (75 watts input) and fed 62 watts to this mobile antenna from an efficient transmitter. Despite their high cost, mobile and special portable antennas usually don't even equal the performance of a random length of long wire located as high and clear as possible and used in conjunction with an antenna tuner.

Tuners. Simply stated, the antenna tuner adds inductance in series with short antennas to increase their electrical length or adds capacitance in series with long antennas to decrease their electrical length. One of the best long-term investments you can make is to purchase an antenna tuner with a built-in SWR meter. The antenna tuner has become a necessity with most modern transmitters because the manufacturers are leaving the antenna matching circuitry out of their units and hams haven't sense enough to raise a fuss.

Material. As a general rule of thumb, use good insulators and the best possible materials when building antennas. Avoid the plentiful power line type of brown insulators; they are relatively lossy at the frequencies you'll be expecting your antennas to operate on. The copperweld type of conductor has a steel center with assures a constant antenna length and a copper outer coating which assures good radiation characteristics; this is a preferred type of antenna conductor which will allow you to build an antenna which will not lengthen out to lower resonant frequencies as it is buffeted by wind storms.

Feedlines. Select and use the best possible feedlines. 75-ohm twinlead and RG-58/U coax are so lossy that they should never be used, even at the lowest frequencies. Old-fashioned open-wire feedline is excellent, as is RG-8/U coax. Transmission line length is not critical unless the line is radiating energy, which it should not do. The function of the transmission line is to transfer the rf output from your transmitter to the antenna input. Think twice about purchasing any antenna which has a stated critical transmission line length.

SWR. Don't strive for perfection in getting your SWR down on each band. It is good to keep the SWR low because it is obvious that we want our transmitter's output to be accepted by the anenna and usefully radiated into space, rather than to be reflected back towards the transmitter. Nevertheless, you can live with a bit of reflected power and you should not be concerned once you get the SWR below 2.5:1.

Grounds

General. You must establish an excellent dc/rf/ac ground if your station is to be operated safely and efficiently. There is

nothing which is more important to one's station despite the fact that many hams stumble along with inadequate grounding. Eight years service on a TVI committee provided plenty of proof that hams are not careful enough in establishing dependable grounds. Don't assume that a wire connected between your transmitter and a ground rod, ac conduit, water pipe, or radiator provides an adequate ground at all frequencies. Ground rods are ineffective when they are driven into a non-conductive material such as sand. An ac conduit which is satisfactory at 60-Hertz housepower can offer several thousand ohms impedance at the radio frequencies you'll be trying to ground. Water pipes are often made of materials which are poor rf conductors; even when good rf conductors are used for piping, they are usually insulated from each other by sealing compound, dirt, and oxide between pipe sections and couplings. Pure water is an insulator, so the better your water supply the lousier your ground will be when you depend on conduction through the water in your pipes. Steam lines and radiators are usually inadequate grounds due to the use of poor rf conducting materials and poor electrical continuity between sections of the system.

Need. Remember that a good ground is vital to the efficient and safe operation of your station. If you are using Marconi and Hertz antennas, you can easily have thousands of ohms impedance between your transmitter's chassis and actual ground, which will cause you tremendous loss in the amount of rf output power you usefully radiate. In addition, all your equipment bypassing and shielding is tied to the chassis which must be connected to a good external ground if they are to be most effective. Don't underestimate the importance of a good ground system and make sure all of your station equipment is tied to a common ground system. It is best to attach your main ground line directly to your transmitter's ground post and then to connect ground lines to your other equipment from that point.

Water pipes. If you find it necessary to depend on your water line for a ground, make sure you make excellent mechanical and electrical connections to the ground point. Coat the connection with white petroleum vaseline (preferably mixed with a

Operate; don't do any building until you get your General Ticket.

little Molykote) and you'll have an excellent electrical contact which will not become oxidized and ruined. You must take care to clean your connection point down to bare metal and to make certain that all pipe sections have the best possible electrical bonding all the way back to your input water meter. Don't even assume that your water meter provides a good ground path because they often require a good ground jumper.
Braid. It is quite possible that your station may have adequate grounding on one frequency (band) and inadequate grounding on other frequencies (bands). The groundline length itself could be a resonant quarterwave at a particular frequency and this would make it serve to insulate your transmitter from ground rather than to connect the two points. It is best to use thin flat copper sripping or braid to connect your rig to ground and it sometimes helps to connect to several ground points using ground leads of different lengths.

An inexpensive way to obtain good ground braid is to purchase old RG-8/U (or similar) coax, peel the outer covering off, and strip the shielding braid off the inner conductor; this shielding braid makes excellent ground leads. Don't bother using lugs on ground

braids of this type; just clean the connection point down to bare metal, flatten and trim the end of the braid, solder the end of the braid for about one inch, and then drill a hole through the soldered braid end to slip over your grounding screw. If you don't intend to use ground braid, at least use the largest multi-stranded wire you have available; those 22-gauge ground leads leave a lot to be desired.

Ground rods. If you decide to use a ground rod and your soil is rather non-conductive, it would be best if you dug out a 25 to 75 cubic-foot hole and specially prepared a good ground by mixing cheap salts into your soil before refilling the excavation and implanting your ground rod. Some hams take the time to install 6 to 12 quarter-wave radials (like spokes from a hub) for each band and this is an excellent ground system. These ground radials are often just aluminum guy wires buried 6 to 12 inches below the surface of the ground.

Effectivity check. You can run a quick check to determine whether or not your ground system is acceptable. Load your transmitter to full input, using your antenna for a load. While running full output (with your key closed), touch your finger against a bare metal portion of your transmitter's chassis or cabinet; if your ground is good, your plate current will not budge when you touch the transmitter. If your ground is poor, you'll have a warm sensation (light rf burn) at your fingertips and the plate current will vary noticeably when you touch the transmitter. Conduct the first check with your fingertips dry; if you don't experience any rf tingle, wet your fingertips and repeat the check. This check should be conducted on each band you are going to use.

Operating the station

Compatibility. When operating your station in the house, don't be a grouchy old bear when others make normal noises as they continue their usual household routines. It is good practice to concentrate on what you are doing to such an extent that you are not distracted by regular household noises and activities. Don't blast everyone into submission either; use earphones to lessen the chance of bothering others.

Two meters. Keep away from the 2-meter band; it has proven a death-trap to thousands of Novices who would otherwise have progressed to their General-class tickets long ago. Most Novices who make the mistake of operating on 2 meters and up as Technicians who have a rough time upgrading to their Generals. Don't kid yourself that you'll operate code on two meters; there's not enough good code operation there in a year to match one day's use of the 40-meter Novice band. Keep off 2 meters and spend your time on the productive 15, 40, and 80 meter Novice code bands. It will be a blessing when the FCC eliminates Novice voice operating privileges on the 2-meter band.

15 meter. The 15-meter Novice band provides opportunities to contact all parts of the word. Fifteen-meter oeration does require a good receiver and the best 15-meter antenna your finances (and space) will allow. It is true that the Novice 15-meter band extends from 21.1 to 21.25 MHz, but you' quickly learn that almost all the activity is between 21.1 and 21.16 MHz, so purchase crystals which provide outputs in this frequency range. It is wise to operate 15 meters whenever it is open and then to move down to 40 or 80 when 15 closes down.

40 meters. The 40-meter Novice band provides contacts with hams all over the country plus occasional contacts with foreign countries. Forty meters is consistently the busiest Novice band and it can be used to good advantage both night and day. The foreign broadcast stations do raise heck in this band when conditions are good, but you'll soon learn that you can work around (or through) them with excellent results.

80 meters. The 80-meter Novice band is usually a little less hectic than 40 and it can be used to get those relatively long contacts which do so much to help build up one's code speed. Make good use of 15, 40, and 80; don't make the mistake of stagnating on one band.

Operating schedule. Set a reasonable operating schedule and stick to it. You should be operating (not just listening) at least 7 hours per week while you are a Novice, preferably one hour per day. You don't need a ham ticket to be a shortwave listener; if you have a license, use it!

Calling and listening. Learn to keep your

CQ calls brief and to listen carefully for answers before sending another CQ call. The major difference between a good operator and a poor one (one who makes very few contacts) is that the good operator expects an answer to his call and he listens very carefully to hear anyone who answers. After sending a CQ call, slowly tune above and below your transmitting frequency for an answer. Do not SWL or 'read the mail' after sending a CQ call; as soon as a station sends even one letter which is not part of your call sign, tune past him and listen to the next station. If you don't hear an answer close to your transmitting frequency, tune above and below your frequency a bit further and faster. If you don't hear an answer within 2 minutes of tuning, make another brief CQ call on the same (or a new) frequency. Most answers are received close to one's transmitting frequency and slow careful tuning, plus proper listening habits, let you spot answers; fast panic-type tuning does not produce good results. Poor listening techniques can make answering operators wonder whether or not you have your receiver turned on; please put your brain in gear before you operate on the ham bands.

It is easier to send from written text until you become experienced and more at

Don't assume that all distributors recondition or check out used equipment before reselling it . . . because they don't.

ease. You have enough trouble at first without worrying about what to send. To make initial transmissions a little easier for new operators, here is a series of typical transmissions which you can use by just substituting your own call:

CQ CQ CQ CQ CQ DE WN7ABC
CQ CQ CQ CQ DE WN7ABC WN7ABC
CQ CQ CQ DE WN7ABC WN7ABC WN7ABC AR K

WN7ABC WN7ABC WN7ABC WN7ABC WN7ABC DE W6DDB W6DDB W6DDB AR K

W6DDB W6DDB DE WN7ABC BT GM ES TNX FER DE CALL BT UR RST 579 ? 579 HR IN SEATTLE, WASH ? SEATTLE, WASH BT NAME IS JOHN ? JOHN BT HW ? W6DDB DE WN7ABC AR K

WN7ABC DE W6DDB BT R ES TNX BT UR RST 579 ? 579 HR IN BURBANK ? BURBANK ES NAME IS BILL ? BILL BT

(at this point, this station opens the general conversation on anything he wishes—equipment, antennas, weather, job, family, etc.)

That first QSO. When a new ham makes his first contact on the air, he usually feels pretty much like the hiker who walked off the cliff's edge; that last step was a dilly! There have been cases where new hams have become so panic-stricken by answers to their CQ calls that they just turned off their gear and ran out of the shack; there have been other cases where they didn't wait to turn off the gear before fleeing the scene! Just do the best you can do and keep your contacts short until you become relaxed enough to enjoy longer on-the-air conversations with your fellow hams. Remember to keep your calls short; long CQ calls net you very few answers but lots of enemies.

Sending speed. Send slowly and carefully. Accuracy is far more important than speed. No one enjoys a contact with a ham who makes frequent errors but errorless code sounds good even at very slow speeds. Don't send code at a rate which is faster than you can copy comfortably. Remember that your sending speed is naturally faster than your receiving capability so make yourself slow down by sending very carefully. Don't speed up to work Generals you hear in the Novice bands; they come into your bands to give you a contact with a new station/state, to give you a little additional code practice, to help you learn proper operaing techniques, and to send you a card. The Generals will be patient with you so don't

hesitate to ask them to slow down or to repeat information. Your fellow Novice is much more likely to be impatient with you than any General.

Sending accuracy. Make clear corrections of sending errors. If you goof the first letter of a word (or a single-letter word), send an error sign and go back to the start of the previous word. It is acceptable to use a series of seven (or more) dits as an error sign or to send a question mark for this purpose; the question mark is the preferred sign to indicate a repetition.

Identification. Include a 24-hour numechron-type clock in your station, complete with a 10-minute warning buzzer. It is best to keep your log in four digit 24-hour time (0000–2400) rather than to bother with AM and PM time designations. As you become increasingly proficient (and as you start to work foreign stations), you will find it more convenient to do all your hamming and logging in Greenwich Mean Time (GMT/Z), rather than in local time. Remember that we are required to identify at 10-minute intervals during long transmissions, as well as at the beginning and ending of each transmission which is 3 (or more) minutes long; obey the law and identify both stations each time your 10-minute buzzer sounds a warning.

Keys

Handkey selection and mounting. Do not use a cheap handkey either for code sending practice or for keying your transmitter because a poor handkey can ruin your sending. Purchase a top-quality handkey and mount it in position at your operating table so that it can't move. The handkey should be mounted where it is easily within reach and in line with your forearm, with your arm comfortably positioned on the surface of your operating table and your elbow on the table. A good handkey has adjustable pivot points, contact spacing, and spring tension; it also has a smooth keying action and large serviceable contacts. Avoid handkeys with large knobs and skirts (bottom knob plates) because they tend to let one develop lazy sending habits which are hard to break. If you can't mount your handkey directly on the surface of your operating table, mount it on a board which is no thicker than three-eighths of an inch and which has good adherance qualities so that it won't move about as you send.

Handkey use. Make yourself send correctly with your wrist rather than to be a finger-tapper type of sender. Correct wrist sending sounds better, is less tiring, and includes far less errors. You can force yourself to send correctly by opening up your key contacts to one-sixteenth inch and adjusting your spring tension to where it takes a lot of pressure to close the key contacts. Use he simple system of placing a quarter on the wrist of your sending hand; if you're sending correctly, it will not fall off.

Code monitor/oscillator. Incorporate a code monitor in your station to permit more rapid code speed build-up and cleaner sending. Usually, a combination code monitor and oscillator is a much better investment than a separate code oscillator and monitor.

Bugs and keyers. Don't be over-anxious to leave the handkey to rush to a bug or an electronic keyer. You will not develop the required rhythm on a bug or keyer; it must be acquired with long hours of practice with a good handkey. When you have developed good handkey sending techniques and rhythm (plus a code speed of about 18 WPM), you are ready to learn how to operate the higher-speed bugs and keyers. Please don't practice your bug or keyer sending on the air; learn how to send with the aid of a code practice oscillator before you connect either to your transmitter.

Recorded sending checks. No matter what type of keying device you use, it is good to tape record your practice sending and to set it aside for your critical evaluation two or three weeks later. You can spot your own goofs and correct them with the aid of these recordings. Don't check a recording immediately after you make it because you may still remember what you intended to send and you may automatically read in corrections which don't exist; set the recording aside until you have forgotten it well enough to be able to honestly copy what is recorded.

Logs

General. Maintain an accurate station log in ink. Fill in your name, location, and call sign on the inside front flyleaf of the log so that you can use an "X" throughout the rest of your log to indicate your operation from your fixed location.

Clutter. Do not repeat your emission type, power, frequency, and date entries in the log when they remain the same for a series of contacts; there is no sense in having a cluttered, messy log. Indicate the month and year in the upper left margin of each log sheet and write the day in the blank left margin beside the contact concerned; this avoids wasting log sheet entry lines and makes it easier to spot contact dates. **Equipment changes.** Indicate equipment and antenna changes in your logs, along with all other data which pertains to your operator/station license and your station's operation.

Dog ears. Don't let your log-book pages become dog-eared and torn; just purchase a pair of #20 binderclips at a stationery store and attach one to each bottom edge of your log book. Your logs provide an excellent history of your amateur radio operating achievements and they deserve reasonable care.

QSL Cards

100% QSL. As soon as your ticket comes, order 200-500 good-quality QSL cards. Good cards indicate a better reply ratio than cheap ones. Make it a practice to send a card to each station you work for the first time. Remember that no cards would ever be exchanged if everyone waited to receive a QSL before mailing one. The cards you receive during your Novice operation count towards hundreds of awards you may seek later on when you have your General (or higher) class ticket. A QSL is as much a part of a QSO as the CQ call itself.

Addresses. Thousands of QSL cards end up in the dead letter office each year. There's no sense in using improper addresses. Make it a practice to tell the other ham your name (first and last) and address (including ZIP) so that his card, time, and postage will not be wasted. Don't assume that there's no longer any need to send your name and address just because they finally appear in the latest call book 3 to 6 months after you get your ticket; most hams use a call book which is more than a year old. If you have a call book, check for the other ham's address while you are working him and let him know if you have it okay. There's usually no need to ask a General for his name and address because it should be in the call book you have; just tell him you're going to QSL to the address shown in the (specific issue) call book.

Promptness. It is a particularly good habit to write the QSL out completely during the QSO and then you are ready to continue on with your next complete contact. Indicate sent and received cards in your log and don't file a received QSL until you have checked your log and made sure you have sent your QSL.

Getting the general ticket

Code

On-the-air practice. The best code practice is to operate your station every day. Code-practice tapes and records are not as effective as a regular diet of station operation during which one must copy what the other follows have to say, to answer questions intelligently, and to send QSL cards.

Contests. Participate in as many on-the-air contests as possible. Do not miss the chance to operate in the Annual February Novice Roundup; this contest provides a wonderful opportunity to work many new stations and states in a short time. Keep track of all local, national, and international contests so you'll be able to participate intelligently.

Goal. When your code speed reaches the point where you are making passing runs at 15-16 WPM (plain language), you are ready to take your general-class code exam.

Theory

Clubs. The best way to obtain the theory knowledge needed to pass the 'written' portion of your General Class License Examination is to attend a free licensing course at a local radio club. Most of these courses are advertised far in advance in local newspaper articles, club bulletins, and notices posted at local radio distributorships. If your local club does not conduct Novice, General, and Extra Class licensing courses, do your best to get one started; there's no surer way to obtain a continuing supply of new amateurs (and club members) than to produce them in a club's own licensing classes. A free copy of the 'Licensing Classes' brochure is available to the instructor of any League-affiliated club who requests one from the ARRL. Join a local radio club and actively participate in all its activities. You may not immediately realize how much

benefit you derive from participating in club field days, auctions, hamfests, etc., but you will be learning new things about ham radio all the time. Understand that the newer hams are usually the ones who keep the clubs perking; they are more active than most of the long-licensed hams.

Examination scope. Don't swallow the big lie that the long-licensed ham knew his onions a lot better when he got his General than his modern counterpart; the long-licensed ham may have become an expert due to long association and commendable effort but the simple fact is that he passed a general-class theory exam which was much simpler than the one used today because the modern exam covers many facets of electronics and radio theory which were not included in exams of just 5, 10, or 15 years ago. The modern ham doesn't have to take a back seat to anyone and modern technology is opening the doors to fantastic break-throughs in communications. We've just been crawling along so far and we are about to stand up and walk.

Technician exam use. The Technician/Conditional 'written' exams are the older (easier) general class exams. When you've built your code speed up to the point where you are about ready to take the General exam, it is a good idea to invest four dollars in a Technician exam as a dry-run for the General-class theory exam before you go downtown to take the big test. The Technician exam will point out where you need to do some additional studying before you take your General-class exam.

Summary

Get your Novice license, set up the best possible station, and operate that station as much as possible. The unforgiveable sin is to allow any of your Novice license term to pass without operating. As soon as your General Class License is in your hot little hand, start your campaign to get a higher grade of license. Make yourself a useful member of the amateur radio service.

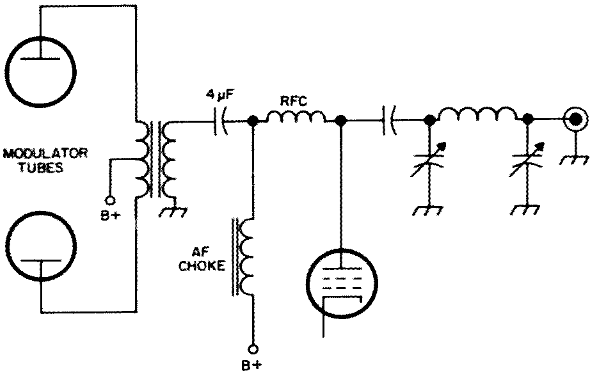
It is realized that some subjects have been brushed over lightly in a sentence or two which would well warrant an entire article, but it is hoped that the main points are adequately covered. There are no big mysteries in the amateur radio service.

. . . W6DDB

Getting the Most out of Small Modulation Transformers

Are you, like me, using an under-sized, over-run modulation transformer, which is running almost red-hot, distorting the audio, and giving low modulation?

Of course, it could be replaced with a much, much larger one, but think of the cost. Strange to relate, one never finds a large mod tranny* going for a few cents in a junk sale!



By using shunt feed as shown here, small mod trannys will operate much cooler and with less distortion. In push-pull modulators it's the PA plate current, not the modulating signal, which tends to saturate.

So what to do?

The answer is simple. Parallel feed, as in the old days, with audio coupling in reverse. Feed the B plus to the PA through a hefty choke, and couple to the mod tranny by means of a hig-voltage condenser of 4 mF.

This removes the heavy direct current from the transformer, which saturates the core. Remember that the current taken by the modulator tubes flows in opposite directions thru the primary windings, and so cancels out. It's the PA current—unidirectional—which tends to saturate.

. . . Douglas Byrne G3KPO

*In case you haven't guessed, a "mod tranny" is British vernacular for modulation transformer!

International Amateur Radiocommunication

The following recapitulation of the International Radio Regulations (Geneva, 1959) concerning communication between amateur stations and transmission of third party traffic by amateurs is published for the information and guidance of United States licensed amateurs:

Article 41, Section 1. "Radiocommunications between amateur stations of different countries shall be forbidden if the administration of one of the countries concerned has notified that it objects to such radiocommunications." Cambodia (XU), Indonesia (8F), Thailand (HS), and Viet Nam (3W) have so notified.

Article 41, Section 2. "(1) When transmissions between amateur stations of different countries are permitted, they shall be made in plain language and shall be limited to messages of a technical nature relating to tests and to remarks of a personal character for which, by reason of their unimportance, recourse to the public telecommunications service is not justified. It is absolutely forbidden for amateur stations to be used for transmitting international communications on behalf of third parties. (2) The preceding provisions may be modified by special arrangements between the administrations of the countries concerned."

Arrangements permitting third party communications have been effected between the United States and the following countries only:

1. Argentina
2. Bolivia
3. Brazil
4. Canada
5. Chile
6. Colombia
7. Costa Rica
8. Cuba
9. Dominican Republic
10. Ecuador
11. El Salvador
12. Haiti
13. Honduras
14. Israel
15. Liberia
16. Mexico
17. Nicaragua
18. Panama
19. Paraguay
20. Peru
21. Uruguay
22. Venezuela

Only amateur stations identified by properly authorized call signs having a one or two-letter prefix beginning with "W" or "K" are authorized by the United States, and third party communication is presently permissible with all such stations except those identified by prefixes KA2-KA9, inclusive.

Hams Cooperate to Locate Endangered Child

Radio amateurs from all over the southwest cooperated in a successful search for a nine-month-old girl who had been given a lethal prescription by mistake. K6EJT, a sightless operator, heard a news report indicating that the prescription was in error and that the family were on their way to southern Oregon. He immediately put the bulletin on the West Coast Amateur Radio Service monitored frequency, 7255 kHz, at 0900 PDT on September 27, 1967. Net Control WA6VIB and a multitude of others spread the information as widely as possible via the Net, to other hams and other agencies. Additional information was gathered concerning the family and the description of their car. At 1543, W6FKQ reported to the net that he had located the family at Oroville Dam in northern California. He advised them of the danger and accompanied them to a hospital. Fortunately the child, Dianne Baida, had taken only a small amount of the medicine and the warning came just a few minutes before the parents were about to administer another dose.

The parents were, of course, extremely grateful to the amateur radio service, as were the various law enforcement agencies from four states who participated in the operation.

Known to have been instrumental in the search were W6VNI, WA6HYU, WB6KOH, W6MLZ, W6DZJ, with several hundred others assisting.

West Coast Amateur Radio Service, monitoring 7255 kHz for the purpose of providing service to the public and other amateurs during the daylight hours, always has at least 50 stations listening on the frequency. ■

Tristao Tower Catalog

A new 24-page catalog for the complete line of Tristao Towers has just been released. The catalog includes, in addition to their complete line of towers, all accessories, guying charts, and other general information. Each tower is briefly described and lists the price range, thus making for quick reference.

The new catalog is easy to read and is fully illustrated. Anyone desiring a free copy should write to Tristao Tower Co., P. O. Box 115, Hanford, California 93230.

Station Custodian Al Lee W6KQI. Photo by TRW Systems Photo Lab.

Long Live the Queen

The ocean liner, Queen Mary left Southampton, England on October 31, 1967 on her last voyage under the ownership of Cunard Lines. This last voyage of the stately Queen took her to Long Beach, California via Lisbon, Portugal, the Canary Islands, Rio de Janeiro, around Cape Horn then north to Chile, Peru, Balboa, and Acapulco with the trip taking nearly six weeks.

Four California hams were on board and were honored by the British government with the special call sign GB5QM for this special event. The amateurs who participated in this event are Al Lee W6KQI, Ray Harter W6HO, Ray's wife Jean K6TUE, and Walt Barnes K6IMK.

Equipment for the station was provided through the courtesy of the Swan Engineering Company.

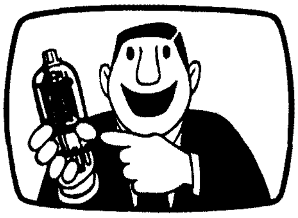
Boy Scout Jamboree

More than 160 Cub Scouts and Boy Scouts of Greater Lawrence, Massachusetts were given a chance to talk to other scouts throughout the world by amateur radio recently from Camp Onway, Raymond, New Hampshire.

The Jamboree station of the air was set up by Scouters William C. Loeffler and Fred J. Waters who hold the call letters of W1PFA and W1GPV. Antennas were strung up among the pine trees, and scouts from ten different countries were contacted. More than fifty contacts were made in the U.S.A., including the World Jamboree station W7WSJ at Faragut State Park in Idaho.

Among the DX worked were: Germany, England, Peru, Norway, Panama, and Antarctica. Only contacts with other Scouts are counted.

Hams who have any connection with the Scout movement are urged to participate in future Hamborees. What better way to get youngsters interested in our great hobby than an activity like this one with the Scouts. ■



NEW PRODUCTS

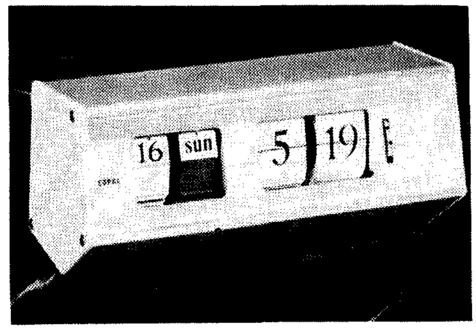
Omega DA Keyer

Omega Electronics Company introduces the DA Digital Automatic IC Keyer. The DA is fully solid state using six dual integrated circuits, two transistors, and one diode for an equivalent of 100 semiconductors. The DA is a double paddle "squeeze" type keyer with both dot and dash memories. Most letters are formed with a single squeeze, enabling an inexperienced operator to master automatic sending in a short time. Provision is made for use of an external straight key to provide remote keying and monitoring. The monitor is self contained, eliminating the need for any connection to a receiver. $85.00 F.O.B. San Diego, California. The optional 6.3 Vac power supply is priced at $12.50. Omega Electronics Co., 10463 Roselle St., San Diego, California 92121.

Drake FF-1 Fixed Frequency Adaptor

The Drake Model FF-1 Fixed Frequency adaptor is a solid-state frequency-determining unit. It provides crystal control of any two operating frequencies falling within the normal operating range of the TR-4 Transceiver (operating frequencies outside the normal range may be feasible with realignment depending on the band and frequency excursion). The FF-1 is well suited for net operation since it provides crystal controlled transmit frequency with VFO controlled transmit and receive frequency. $24.50 Amateur Net.

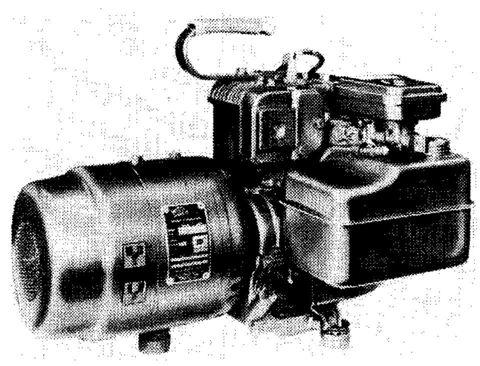
Caslon Digital Electric Calendar



The newest member of the Caslon clock family is the Model 601. This beautiful time-at-a-glance unit is designed for desk or table. It is housed in an attractive aluminum case and has a noiseless precision motor which provides exact time keeping. Having no hands, the easy-to-read digital cards indicate the time by flipping the minutes into hours. Every five seconds is also indicated by a rotating dial. An added feature is the date and day of the week, with each day of the week having its own color card. A built-in diffused pilot light keeps constant vigil through the night.

Write to Ropat, 5557 Centinella Boulevard, Los Angeles 66, California for additional information on this unique, up-to-the-minute clock. Retail Price $49.95.

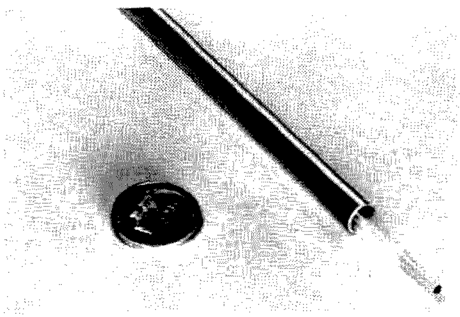
Winco Pace-Setter Alternator



Wincharger Corporation, subsidiary of Zenith Radio Corporation, Sioux City, Iowa, announces the new Winco Pace-Setter portable power alternators. These new alternators offer economical, compact, lightweight, portable power for amateurs, contractors, utilities, fire departments, campers, home and farm. The new Winco Pace-Setters are made in three popular sizes: 2500 watts, 1750 watts, and 1250 watts.

For complete details and prices, contact Wincharger Corporation, 1805 Zenith Drive, Sioux City, Iowa 51102.

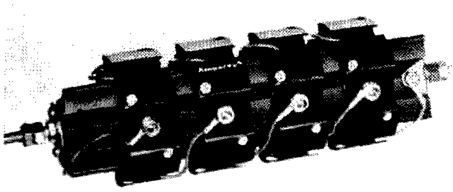
Alumispline Semiflexible Coax



A newly designed semiflexible coaxial cable made with a tubular or solid center conductor, which is completely enclosed by a dielectric consisting of five longitudinally extruded splines is available from Times Wire and Cable, a division of International Silver Company. This new cable is ¼ inch O.D. size and exhibits VSWR's of 1.06:1 at C-band.

The new cable is designed to be used at frequencies up to 15 gHz. It's construction allows it to be bent on a 2½ inch bend radius without the creation of reflections. The cable is especially useful for phased array antenna applications where good phase performance, low attenuation, and little reflections are required. It is now being stocked in 20 to 24 foot lengths. For further information, write to Times Wire and Cable, International Silver Company, Wallingford, Connecticut.

Amperex High Voltage Silicon Rectifier Stacks



Amperex Electronic Corporation has announced the introduction of a new line of high voltage silicon rectifier stacks. The line consists of three families designated as the OSB-9210, OSM-9210, and the OSS-9210. The entire line can deliver an average forward current of from 5 to 20 amperes depending on the method of cooling employed when used as half-wave single phase rectifiers. An important feature of these stacks is that they can withstand high surge and peak currents. They can also withstand a maximum non-repetitive peak current of 360 amperes for one cycle of sinusoidal current at 60 Hz.

For further information please contact the Product Manager, Power Devices, Amperex Electronic Corporation, Slatersville, Rhode Island 02876. Phone 401-762-9000.

Blonder-Tongue RF Switch

A new switch, the Model 4130, is a handy aid for testing rf devices in the frequency range from DC to 900 MHz, has been announced by Blonder-Tongue Laboratories, Inc., Newark, New Jersey 07102. The model 4130 is a manually-operated unit consisting of a 75-ohm DPDT coaxial switch and an eight-pole, double-throw wafer switch. The coaxial switch permits selection of two rf signals, such as the input and output of a device under test.

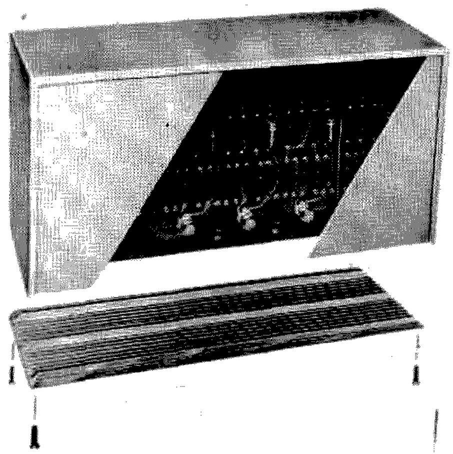
The eight-pole, double-throw wafer switch may be used for controlling associated dc or low-frequency circuits. The coaxial switch section has a frequency range from DC to 900 MHz, so that it can be used on TV sub-channels 2 to 83 and FM. All switch contacts have a power handling capability of 2 amperes maximum.

Versatile Storage Bin Units

Bay Products has come out with some extremely useful Bin Units with adjustable shelves on 1½″ centers and have full-width label holders. The bin dividers are secured with "snap-fasteners" and can be adjusted horizontally on 1″ centers. Bay Bin Units are also available with drawers or sloping bin dividers, or in combinations using both within the same unit.

Literature and prices are available from Bay Products, 155 E. Somerset St., Philadelphia, Pennsylvania 19134.

Multi-Mod Extruded Aluminum Cases



Vector Electronics Company has introduced a new line of "Multi-Mod" aluminum cases suitable for housing instruments, controls, circuitry, and miscellaneous small equipment. These cases should be applicable to many ham building projects.

The cases consist of a wrap-around extrusion available in 1.6", 2.0", 3", and 4½" widths and are eye appealing in that they contain screws on only one of the six sides. All joints overlap to provide excellent rf shielding. The interior surfaces have parallel grooves to hold circuit boards running the long dimension of the case.

For further information contact Vector Electronic Co., Inc., 1100 Flower St., Glendale, California 91201 Phone 213-245-8971.

Technical Manual Catalog

If you have been looking around for a manual for a piece of surplus equipment, you're missing a good bet if you don't have Quaker Electronics' new *Technical Manual Catalog*. This catalog lists hundreds of out-of-print TM's and instruction books which are practically unobtainable. In addition, if you need a particular TM that Quaker does not have in stock, they will try to locate it for you. The *Technical Manual Catalog* is 25c from Quaker Electronics, P. O. Box 215, Hunlock Creek, Pennsylvania 18621.

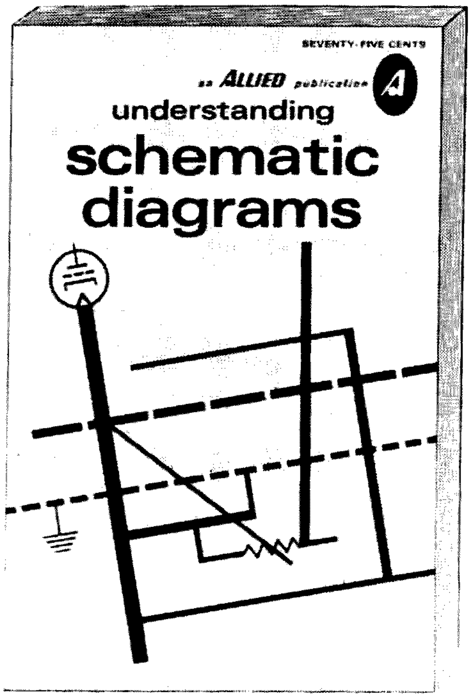
Motorola HEP Semiconductor Catalog

The latest edition of the Motorola HEP Solid-State and Projects catalog introduces eight new HEP semiconductor devices which will be of interest to the hobbyist, ham, experimenter and service dealer. The catalog is available from any HEP distributor or by writing to Motorola HEP, P.O. Box 13408, Phoenix, Arizona 85002.

Northern Engineering Labs Catalog

The new Northern Engineering Laboratories Catalog 367 has a lot of interesting information. In addition to a complete selection of quartz crystals, crystal ovens and oscillators, there is basic information on equivalent circuit theory of oscillators and oscillator design data along with a listing of the characteristics of various crystal cuts, listing the advantages and limitations of each. Material is also given on the selection of a crystal oven. For a copy, write on your company letterhead to Northern Engineering Laboratories, Inc., 357 Beliot Street, Burlington, Wisconsin 53105.

Understanding Schematic Diagrams



This new book, although entitled *Understanding Schematic Diagrams*, covers much more—it is actually a rather comprehensive introduction to the subject of electronics. Edited by Julian Sienkiewicz, the book explains in non-technical language the functions of components, their use in electronics circuits, and the symbols and techniques of schematic diagrams. The material in every chapter is made easy to understand by the generous use of illustrations and diagrams. Two pages are set aside in the back for all of the commonly used electronic symbols. 75c postpaid in the U.S.A. from the Allied Radio Corporation, 100 N. Western Avenue, Chicago, Illinois 60680.

1968 Heathkit Catalog

The new 1968 Heathkit catalog, illustrating the world's largest selection of electronic kits, is now available for the asking. This 108-page kit-builder's dream book has 56 pages in color and boasts over 300 kits for every budget and interest. It contains complete lines of amateur radio equipment, stereo/hi-fi components, test and lab instruments, CB, Photographic aids, TV, electronic organs as well as many others.

The new catalog also illustrates actual kit assembly manual pages. Just mail a post card or note with your name and address to the Heath Company, Benton Harbor, Michigan 49022 to get your free copy.

Gus Browning W4BPD
Cordova, South Carolina

Gus: Part 31

In last month's episode, I was on my way to Durban, South Africa via train. I had plenty of time to think along the way, mostly about the radio gear I had in those three suitcases, which the government didn't know I had in their country. Equipment I had been told I would never get out of the country again. Being on a DXpedition, this did cross my mind.

I was met at the railway station in Durban by three well known DXers: ZS5QU, ZS5JY, and ZS5JM; Roy, Oliver, and John. The first thing, as usual, was Cokes for us all. Oh yes, there are Cokes in South Africa, but by the time I departed there were a lot less.

I visited Roy's QTH first, where I met his beautiful wife, Pam, and got a demonstration of the hard way to control a VFO. Roy lived on the top floor of about a six-story plush apartment and was using some rather old surplus-looking gear. On one which has been designed as a crystal controlled rig, Roy had installed (I use the word installed rather loosely) a home brew VFO. Now, fellows, I have seen lots of VFOs, and have built 35 or 40 of them myself, but to this day I have never seen one that was built more haywire than that VFO Roy had hanging out of the side of his rig. His rig was turned up on its side, and he told me it has always been sitting that way. The VFO was only supported by the wires from it to the rest of his rig and the VFO's power supply. Now get this . . . it had no tuning capacitor to change frequency. To change frequency, he turned the slug with a small screwdriver, and when the screwdriver touched the screw in the VFO, the frequency jumped about 43.7 kHz. Plus this, his hand made it change 11.2 kHz when it was placed near the VFO while tuning it. Can you picture Roy trying to zero in on a station? Well, he could do it. I tell you fellows, that's doing it the hard way. It involves tuning the receiver 53.9 (thats 43.7 + 11.2) kHz below the station he wanted to zero in on. Remember, the receiver he was using was not too well calibrated either, and this made it that much more interesting watching him. Well, all I can say is he certainly did not tune up on top of anyone by this method. Roy now has a new rig, but that VFO would make Ross Hull turn over in his grave, and T.O.M. weep. It should be placed in the ARRL's museum of real "haywire". The art of haywire may soon be gone, and, if possible, should be revived before all us oldtime haywirers are pushing up daisies.

Anyhow, there I was at the home of Roy and Pam, after all the many QSOs I had had with him all these years. Roy is a young fellow and I would estimate his age at about 30 when I was there. He had a very efficient antenna (a ground plane) and it was defiinitely not haywire. How Pam stood for that haywire rig and VFO in that modern up-to-date apartment, I don't know, but they were a happy couple and looked as if they were living a very nice life.

Next, we went over to John's (ZS5JM) operating site, which was on the outskirts of Durban. It was some five to ten miles from the city, down beside the beach. His father and mother lived there year round, and John and his wife, Maureen, usually stayed in the city during the week and came out there on the week end to operate, swim and boat.

I have a strong opinion that John went there mostly to do some DXing. He had a fine looking rig that used either one or two 813's and a 3-element beam that was hand tuned. Boy, this beam sure did make those W/Ks boil through, some of then S-9 plus. I told John I wanted to return there with my rig and set it up and do a little operating from that QTH with that beam. The beam was on top of a 50-foot homemade tower. This tower looked almost exactly like a windmill tower, only it was made from wood and it was unguyed.

After drinking a few more Cokes and

talking to John's mother and father for a wonderful eyeball QSO, Oliver (ZS5JY) and I departed for his QTH some 30 or 40 miles down the coast from Durban. Oliver had a Mercedes-Benz and he had a real heavy foot, too! With that high speed traveling, we covered those miles in very short order. Oliver's home is out on a sugar cane plantation, which covers a tremendous amount of acreage. I don't really know how much, but a wild guess would be maybe 10,000 acres and his house is about in the middle of it. He had plenty of Cokes in the Fridge.

In the garage, there were two Mercedes-Benz, both exactly alike. One for the nice XYL, and one for Oliver. His station was very nice. He had a Collins S-line and even a 30L-1, which he called his "beam". In the yard, besides his private tennis court, was a fine home-brew 5- or 6-element beam on top of a good high windmill-type tower. I found that Oliver could *tune* the beam from the operating position with two push-buttons and could get the SWR down to 1:1 on any part of the 20-meter band. I think the two push buttons controlled a small motor that, in turn, tuned a capacitor connected to the Gamma rods, or something like that. Anyhow, it worked great. Oliver turned over the station and his home to me and told me to go in the air whenever I wanted to, stay up as late as I wanted, and sleep as late as I wanted. He said to help myself to the cokes, and if I felt like it jump into the swimming pool. Now, fellows, this was what you might call DXing *deluxe*. I had three weeks to wait for my ship, so I had some mighty fine QSOs from there. Although ZS5 is not rare enough to be exciting, I had some little pile-ups from there when I turned up on my usual frequencies for the Gus watchers.

I had plenty of time to visit all around the place, and saw many ZS5 stations, and as usual, I found all of them just as nice as DX'ers I met at all the other places I had visited in my travels.

Oliver even had a big get-together one night for me. All the ZS5's from around Durban showed up, and there was quite a bit of drinking, fancy eating, swimming, etc. As for myself, I never had it so good. While they were drinking all kinds of stuff, I stuck to my Cokes, as usual. Oliver was a wonderful host, and the gathering was a very nice one.

Oliver was a graduate of some sugar in-

stitute in Louisiana, and was a good friend of Ack's (W4ECI) while he was going to school there. Oliver has a sugar refinery where all the sugar cane is squeezed out, the juice boiled out, and it all ends up as some of the best sugar in the world (according to Oliver). This is a very modern refinery and all the very latest machinery and methods are used.

Plenty of the ZS5 fellows were always on hand to take me here and there when Oliver was tied up with his business. Many hours were spent in Durban watching the Zulu Rickshaw boys with their colorful costumes. They are very tall, husky fellows and never did seem to tire out when they had a paying customer in their rickshaw. They could cut flipflops right in the middle of traffic and not even let loose of the two handles of the rickshaw. Those rickshaw boys were about the happiest lot I have ever seen anywhere. We visited museums, zoos, and snake houses. Lots of interesting times and sights were seen and had in and around Durban, South Africa. It is a sea-port city with wonderful temperatures they say, all year round. Oranges and other citrus fruits grow well there, but to me it looked as if sugar cane covered the most acreage.

I visited ZS5QU any number of times and for some strange reason that VFO always seemed to draw my eyes in its direction. I spent a number of days out at ZS5JM's QTH, operating right on the seacoast with his beam. The long path openings to the states were fantastic.

Time was coming to depart, and I began thinking about how to get that radio gear out of the country so I could take it home with me.

Note: Well, Peggy and I are back from our vacation and things are beginning to jump again with my *DXer's Magazine*. I did get up my 150-foot tower and now am starting on the 4-element tri-band quad to put on top of it. I gotta get this job done before cold weather sets in. Plus the fact that I want to be able to hold my own in some of the DX pile-ups which are heard occasionally on the bands. Looks like I may have a 40-meter quad up one of these days too, so look out, fellows. I am tired of being trampled on. I want to come up for air and I hope I will be in there with the top layer boys again.

. . . W4BPD

Letters

Bricks and Bouquets

Dear 73,

I wish to thank you for your article "A Stable VFO for SSB" in the November 1964 issue of *73 Magazine*. I built this unit for a total cost of less than $6.00 and used the chassis, cabinet, tuning coil and capacitor from an old Heath VF-1 VFO. It works beautifully. Drift is about 100 Hz, which is negligible.

I have built several small projects and found your VFO to be the most satisfying one so far. Thank you.

Fred W. Fetner, Jr. WB4EFA
Rock Hills, South Carolina

Dear 73,

I would like to compliment you on the series, "Climbing the Novice Ladder". I am not a ham yet, but I found it was a help and encouragement to me.

Joe Martenson
Santa Rosa, California

First let me thank you for the fine job on *73 Magazine*. I have taken it (plus *CQ* and *QST*) ever since it came out, and have gotten many fine ideas and information from it. It carries so much more construction dope than the other two.

I also purchased from you, the fabulous *RSGB Handbook* some time back, and it is so good that I also purchased from you recently, the *Technical Topics for the Radio Amateur*, by Pat Hawker. It really is a gold mine. Thanks again for your fine magazine, and keep up the good work.

Chester M. Benson W9IFB
Richmond, Indiana

Dear 73,

After reading your DXing aricles in September 73, I won't "bug" you with the details of my vertical and 150 watts of CW. But you bug me at times. But I enjoy the magazine, so no matter how outrageous you get, I will still subscribe for the excellent constructional articles.

The SSB/AM hoo-hah is a dilly! It's "yak-yak", no matter how it's dressed up. A good el-bug in the hand of a good man can make sweet music to the initiated, as you well know. Keep on the good work and more power to your elbow.

R. W. Armstrong G3PGC
England

Dear 73,

In reference to the SSB versus AM controversy, after being away from the amateur radio bands for almost two years, I honestly did not think the battle would still be.

The world is changing, and with it—man. Because we are advancing technically, there has developed a problem, not of credibility, but compatibility. Since history, this pattern has been repeated by man. In the end, progress has destroyed or modified that which is not compatible with present or future needs.

Carefully, slowly, and with difficulty, the old is replaced. For science is a search for truth, and the truth renovates and reshapes the old making it useful. Unfortunately amateur radio, being a hobby cultured by individual attitudes, ignores what is fact and fantasy.

The next time one "gets on the air", he should think: Am I doing what amateur radio is—not what it was, or will be? Am I in any way contributing to the advancement—not of amateur radio—but to welfare or mankind and this society in which we live? Am I so selfish that I will disdain possible truths that are of benefit to everyone? Fellows, *stop*, and live a little.

Charlie Channel WA6ZLK
Venice, California

Dear 73,

. . . In your October issue Letters, there is a well written article that just about says what the whole ham radio picture looks like to an outsider. I was going to start a ham club at my high school, but there weren't enough people to attend the code and theory classes. Most kids liked the idea very much, but as one fellow put it, "When you have your license, equipment, and are all primed and loaded, there is such a mess on the air at night after school that there isn't even any use getting your ticket because you won't be heard anyway". I wonder how many of the rest of the fraternity would still be licensed and active if they had to start all over again now.

When I read your Letters column every issue, I find nice little arguments between SSB and AM, with such niceties as "slop bucket, silly side band, stupid slot brain" and others a 13 year old isn't supposed to say. Against the AM crowd are things like "ancient modulation, agonizing mess, etc.", and such things make me mad. I thought ham radio was a hobby of builders and tinkerers, not a battlefield between ancient modulation and slop bucket.

I'm sending my picture so when the two rivals read this they might throw darts at it.

Stephen L. Blakley WN7GUC/WA7GUC
Phoenix, Arizona

Dear 73,

Re your article "The Death of Amateur Radio" in the November issue. I am sure that Mr. Zurawski does not know all the facts! First of all, going through the efforts of passing the examination is a challenge to me. I plan to take the General Exam in a week and hope to conquer that goal. Secondly, I disagree that all hams are appliance operators. I converted my own ARC-5 transmitter, built my own power supply, and strung my own antenna. Since the three most popular Novice rigs are in kit form, I think this indicates something. Sure, SSB is more complicated, so most hams don't risk building it, but there is nary a shack in which there is not some homebrew equipment.

Now look at the kid who has to decide between CB and real radio. He sees this article telling how it's so easy to run a kw on CB. What would you do? Keep this discouraging type of writing out of a fine amateur radio magazine like yours.

Bruce Bursten WN9UVE
Milwaukee, Wisconsin

Dear 73,

"When winter comes can spring be far behind?" We have lost the 11-meter band, and big chunks of the 10-meter band are sure to follow. Although they probably won't take it until after the sunspot cycle has declined, thus catching many hams off-guard or in a mood of indifference.

It is up to us as the most-interested parties to come up with a plan for the intelligent, constructive use of these "empty" frequencies if we expect to lay any claim on their retention by the amateur radio service.

I would like to see the Technician Class privileges extended to include A-3 emission, up to 1000 watts dc input, in the top kHz of the ten meter band, i.e, 29.5-29.7 MHz.

If this were done, an even stronger case could be made for the suggestion of permitting Novice phone operation (75 watts maximum), in the same 200 kHz. Since the typical novice operates mostly on 80-40-15 with a five band rig, and should he turn out to be one of the unfortunate 25% who cannot psychologically cope with the code, he could become a Technician and still operate with the same basic rig.

Should we wish to become really radical, why not let the Technician retain his CW privileges in the novice bands with vfo operation and full power thrown in. Who knows, someday he might finally crack that 13-wpm barrier!

Bill Lindblom WAØMNK
Chillicothe, Missouri

AM on MARS

Dear 73,

In the Letters column of your November issue, you made an unfounded and inacurate statement. I refer to the bottom of page 131, first column, where, in reply to Bruce Cline, you stated, "MARS has eliminated AM operation on all frequencies except VHF". This statement is unfounded and untrue!

Marc Leavey WA3AJR
Adelphi, Maryland

Sorry, this statement should have read Air Force MARS. AF MARS has eliminated AM from the HF bands, showing a progressive attitude.

Incentive Licensing

Dear 73,

Attached is a letter to FCC and their reply. The information helped clear up some points for me—it might help somebody else too.

Ken Piletic W9ZMR
Streamwood, Illinois

Exerpts of these letters follow:
Engineer in Charge
Federal Communications Commission
Chicago, Illinois
Dear Sir,

. . . The written requirement for the Amateur Extra class license consists of Element 4A and 4B. These elements appear to be the same as Element 4 of the Commercial examination. If this is the case, it would seem that holders of a First Class Radiotelephone

License (commercial) have already taken this examination. Would you please answer the following questions for me?

1. Are element 4A and 4B the same as Element 4 of the Commercial exam?
2. If so, is the holder of a First Class Radiotelephone license required to take this same test again in order to obtain an Amateur Extra License? Or would such a person be given an Amateur Extra License upon successfully passing only the code requirement before an FCC examiner
3. Would an Advance Class License automatically be given to General Class license holders who also hold a First Class Radiotelephone license?

Thank you.

Yours Truly
Kenneth A. Piletic

Dear Mr. Piletic,

Elements 4A and 4B of the amateur radio examination to which you refer in your letter, are not the same as Element 4 of the Commercial radio operator examination.

. . . The holder of a first class radiotelephone license is allowed no credit on any type of amateur license examination.

Examination credits on amateur radio examinations are given only to the extent specified in Section 97.25 of the Amateur Rules. Applicants for higher classes of amateur radio licenses should review this section of the Rules for information on examination credits. There are no examination credits except as specified in this section of the Rules.

Very Truly Yours
E. J. Galins
Engineer in Charge

'Limited Class' Licensing

Dear 73,

This letter is about what we can do to save amateur radio . . . There are a lot of people who like to talk and have a mild technical interest in electronics. They could be a valuable addition to "our" ranks. At present these people are untrained and naturally go to the "free" (of tests) license of CB. Couldn't we interest them in ham radio by providing a "Limited Class" license? With time they would provide many full amateurs plus a large source of trained voice operators, an asset to the nation.

The "Limited Class" license could provide for equipment which the operator would not change or adjust (until he obtained full amateur rank). Self policing (which CB does not have) must be written into the regulations. A test should be given which shows basic knowledge of the laws and operating techniques (since they would be principally operators). This is about what it takes to get a driver's license. Let's provide incentive for these new hams by providing what they want . . . a place in the spectrum, for example, with a number of fixed channels in our less used bands. Let's limit the power too, in order to provide incentive to become full rank amateurs, but make the power level higher than CB to entice the more intelligent our way.

Let's keep our minds open and active . . . it's the only way to exist. No fighting among ourselves. SSB has its place on crowded bands but AM still sounds great when it can be heterodyne free. Remember the old days, but look to the future. If we don't, then we are *dead*.

R. C. Wilson WØKGI
Littleton, Colorado

All of the qualities you mention in the "Limited Class" license you propose are incorporated in the Novice License, which was the first step in the incentive licensing program.

ANTENNA NOISE BRIDGE

Dear 73:

As the design engineer on the "Antenna Noise Bridge", I would like to express my appreciation for the well written article in the October issue.

Also, I would like to make one note covering the most common problem with the unit. Several of the units have been returned to the factory for repair because the user was unable to find a null. In every case this was due to the use of a receiver with only ham band tuning capability, and the antenna being tested was outside the frequency tuning range of the receiver. In most cases the antenna had been tuned using a VSWR bridge. A VSWR Bridge will give an indication of a 50 ohm impedance which does not necessarily indicate the true resonant frequency of the antenna. It is only at the true resonant frequency of the antenna that maximum radiation will occur. Typical measurements have indicated a significant increase in antenna performance when tuning the system with an Antenna Noise Bridge as compared to operating on the frequency of minimum VSWR as read on a VSWR Bridge. This is particularly true on high Q mobile antennas.

It should be pointed out that if an electrical half wave length of feed line (or multiple) is used between the transmitter and antenna, the actual radiation resistance of the antenna is relatively unimportant so long as the transmitter will load. The fact that the transmitter sees a pure resistive load is of primary importance. If the feed line is other than a multiple of ½ wave length, the antenna radiation resistance must be the same as the coax. Otherwise, the coax becomes a part of the antenna resonant circuit.

An additional question often asked concerns the use of the Antenna Noise Bridge at high frequencies. The production unit will work satisfactorily on 2 meters. For best results above 100 MC, a small trimmer capacitor across the antenna terminal will compensate for the distributed capacitance of the potentiometer and allow usage of the unit to frequencies in excess of 200 MC. The trimmer will allow the dial calibration to remain accurate over the entire range.

R. T. Hart W5QJR
Engineering Associate
Omega-t Systems Inc.

Homebrew Kilowatt

Dear 73,

Did you ever write an article that you later wished you had not written? I have written several. The latest is the 6KG6 KW amplifier appearing in January *73*. The third paragraph states, "It is assumed that the ham who starts out to home brew a kilowatt is not embarking on his first construction project". You wouldn't believe the letters I have received from neophyte hams, who, by their very questions, reveal that they have never built anything at all. So suddenly they decide to build a KW with 2000 volts on it. I sincerely hope nobody gets electrocuted as a result of my article.

I belive you need a good article entitled, "If you want to get your feet wet, start at the shallow end of the pool". Then go on to describe a good linear (or other amplifier) that has a supply of less than 500 volts. Go through it piece by piece and explain what the parts are for and why they have to be within a certain size range. The stock question about the above amplifier was "What's the size of the capacitor between the plate and the pi-network?" This is noted in at least ten places in every handbook in the land. A ham who doesn't comprehend, even vaguely, the purpose and limitations of a dc blocking and rf by-pass capacitor, has no business building anything as lethal as a KW final.

R. E. Baird W7CSD
Klamath Falls, Oregon

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital adds.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

CONVERTER SALE: three transistor, 50-54 Mc in, 14-18 Mc out, wired, tested printed circuit. Crystal controlled, $6 ppd. Adjustable, $5 ppd. Syntelex, 39 Lucille, Dumont, N.J. 07628.

GRAVELY TRACTOR 30" Rotary, 30" Reel Mower, 48" Snoblade, Chains, Governor, Oil Gauge, Hitch, MINT. Cost $750. Trade for TR-3 and DC or SBE 34. Nathan Vance, 908 N. Countyline St., Fostoria, Ohio 44830.

DAYTON HAMVENTION April 27, 1968—Wampler Arena Center, Dayton, Ohio, sponsored by Dayton Amateur Radio Association. Informative sessions, exhibits, hidden transmitter hunt and ladies program for the XYL. Watch the Ham ads for information or write Dayton Hamvention, Box 44, Dayton, Ohio 45401.

WOULD LIKE TO CORRESPOND with a Ham or SWL in Israel. I am 23 years old, male, interested in sports, photography, electronics, & motorcycles. I would also like to receive any Hebrew magazines. I will answer all letters. Wm. Rothstein K3WOL, 341 E. 3rd., Erie, Penn. 16507 USA.

JOHNSON INVADER 2000, legal input on SSB and CW, 800W on AM. Excellent condition, $425. Ed Carpenter, Rt. 7, Box 152, Fairmont, W. Va. 26554.

8121 TYPE TUBES WANTED. Any condition; but state condition and price. R. W. Campbell. W4KAE, 316 Mariemont Dr., Lexington, Ky. 40505.

UPM-70 OS-56. Need schematic or manual. Tom Shinal, W4HCP, 2331 John Marshall Drive, Apt. 101, Falls Church, Va. 22044, 703-532-5899.

TOROIDS: 88mhy, unused, center-tapped, 5/$1.50 POSTPAID. RTTY paper, $3.50/case. Hallicrafters HA-8 Splatter guard modulation indicator $8.50. Ameco CN-144W two meter converter with P.S. $35. Globe/Chief 90A $38. Mainliner tt/L RTTY T.U. $75. Heath TC-2 tube tester $15. Viking tape deck #75 with preamp $45. Typewriter; Royal, 20" carriage, touch/control, table, perfect $35. Dumont 324 scope, $30. Ballentine 300, $35. WANTED: NC-300, Gonset communicator for 2 meters. Rotator, AM mono tuner. Stamp for list. Van W2DLT; 302X Passaic, Sterling, N.J. 07980.

COLLEGE CALLS: must sell NCX-3, NCX-A ac supply, NCX-D dc supply, Hustler (mast, 80 & 40 coils). Package only $375. WA9RNP, 1211 Fairfield, Indianapolis, Indiana.

SELL DRAKE 2B with book $190.00, Johnson Navigator with book $65.00, both very good. James Brennan, RFD #1, Exeter, N.H. 03833. Tel. 642-3421.

WRL's used gear has trial—tradeback—guarantee —terms. SB34—$284.95. 650 & VFO—$89.95, HQ170AC—$239.95; HQ110A—$159.95; 753—$119.95; SB300—$249.95; SR150—$269.95; SX110—$99.95; SR46 —$99.95; G76—$99.95; 75S1—299.00; 62S1—$589.00; Thor 6 & VFO—$169.95. Request free "Blue-Book" hundreds more. WRL, Box 919, Council Bluffs, Iowa 51501.

QSL CARDS???? Samples 35¢. Sakkers Printery, W8DED, Holland, Michigan 49423.

GONSET GSB-2 Communicator w/ac supply $250. Heath HW-22 Single-bander $95. Ray Hein, 147 Grandview Circle, Camarillo, Calif. 93010.

TRADE: General Radio Strobotac, for test equipment CB transceiver Model RC airplane gear, or what have you. W9BPG, 609 Henrietta St., Gillespie, Ill. 62033.

GOING OFF THE AIR—send $3.00 for surprise package. Collins 75A3 $250—Globe Champ 300 $150 —Millen 90651 GDO with 9 coils $40—Hickock 610A TV generator $35—LM20 with P.S. and book $65—LM18 with P.S. $35—60 ft. tower $60 local—TA33 Jr. beam and CDR rotator $50 local—TS239/UP scope and spare tubes $85—2 RCA 7094 tubes new $15 each—UTC CVM3 new $10—Millen 90501 secondary frequency standard as is $20—Triad 33A choke $5—2 Superior powerstats, 7½A type 116B $14 each—1st cashiers check or postal money order received—pastage extra—K1ABE, 130 Bishop Ave., Rumford, R.I. 02916.

FOR SALE—Heath HW-12A with xtal calib. A-1 cond. $105 plus shipping. Getting SB-101. Laurence B. Smith W7FOM, 441 Minnesota Ave., Rte. 4, Missoula, Mont. 59801.

TRI-EX 88' tower, $150. 85' 50 ohm coax, $25. Will deliver within 100 miles of Reno, Nevada. Paul Etcheberry, WA7GHQ, 1220 S. Marsh Ave. 89502.

DISCOUNT PRICES—TIME PAYMENTS. New equipment in factory sealed cartons. Swan SW-500 $430. SW-350 $365. SB-34 $360. Drake R-4B $375. T-4X $349.50. L-4 $599. Send for discount price quote on any type amateur gear. Payments as low as $10 monthly. No finance charge if paid within 45 days. New Ham-M rotator $99.95. Galaxy linear $391.50. Complete selection of National, Drake, Swan, Galaxy, SBE, Hygain, Mosley, Triex, New-Tronics, at discount prices. Reconditioned specials. HW-12 $75. NCX-3 $179. Ranger II $129. 32V-2 $129. Globe King 400 $79. Globe King 500C $199. EDWARDS ELECTRONICS, 1320 —19th St., Lubbock, Texas. 806-762-8759.

SALE: Adventurer $30.00. Heathkits: VF-1 $10.00, QF-1 $4.00, AR-3 $14.00. Morrow 5BR-1 Converter $35.00. Worked 106/60 countries with listed gear. Hallicrafters S-40A $35.00. Zenith S-700 Novice receiver, hardly used, $45.00. K9WVJ, Box 3679, Air Force Academy, Colorado 80840.

WANTED: Record, tape, or lyrics of the song "Gloomy Sunday" from the early 1930 era. WØHJL, P. O. Box 224, Dublin, N.H. 03444.

TRADE: New Wheatstone Perforator; DAVCO DR-30 receiver; RCA SSB-30M transceiver; Mite TT-299 teleprinter; National 200 transceiver. Roy Brougher, W4RRU, 3743 Wesley Drive, Montgomery, Ala. 36111.

WANTED: VIDEO TAPE CORRESPONDENCE with persons having the Ampex model VR6000 series video tape recorders or equivalent of. Jack K. Schmermund, ATVW8VSY, 401 N. Main St., West Milton, Ohio.

P&H LA400C—$89, DX60A $49, HG10B $29, HW32 $89, HP13 $39, H. brew AC for HW32 $25, HW29 Sixer with GP11 DC supply $35, presentation Vibroplex & case $19, Heath AT-1 $19. Navy RBM4 200kc 21 mc—2 recvrs & AC supply $35 all working with manuals. D. Goetcheus W2QH, 92 Genesee St., Greene, N.Y. 607-656-8083.

TELETYPE TEST SET I-193C. Brand new surplus. Tests RTTY transmitters, converters, relays, $24.95, F.O.B. Harrisburg, Pa. Telemethods International, P. O. Box 18161, Cleveland, Ohio 44118.

GEARFINDER: What gear do you need? What gear do you have to sell or swap? Send list to: Gearfinder, 8848 East End Ave., Chicago, Illinois 60617.

ARC-3: SELL two ARC-3 xmtrs, one ARC-3 rcvr, all three complete with tubes for $40. Mann, 4404 Judith Lane, Apt. 1-a, Huntsville, Alabama 35805.

FOR SALE: HRO-60 communications receiver, good cond., with speaker, xtal calibrator and CE Sideband Slicer, $200. HT-32 xmtr, xlnt cond., $200. 4-1000A bandswitching 10-80m. GG linear amplifier with 4,000 vdc power supply, $300. W6KW, 11422 Zelzah Avenue, Granada Hills, Calif. 91344.

WANTED—Serviceable FM communications equipment such as General Electric or Motorola, for use in six and two meter ham bands. Please include model, type, condition, price, and quantity in first letter. K5ZEG, 14221 Sommermeyer, Houston, Texas 77040.

LIL LULU 6-METER PAIR: mobile mount, WWV crystal filter, squelch, ANL, S-meter, product detector, 117/12V supply. $160. K3CXZ, RD Box 90-2, State College, Pa. 16801.

SBE-33 135 watt 80-15 ssb xcvr—$180; Heath SWR meter — $9; Shure 444 Dynamic mike — $13; WB2VTP, Don Nausbaum, 167 Loines, Merrick, New York 516-Ma 3-5808.

WANTED: TEST EQUIPMENT, laboratory quality such as Hewlett-Packard, General Radio, Tektronix, etc. Electronicraft, Box 13, Binghamton, N.Y. 13902. Phone: (607) 724-5785.

PANDORAS BOX transceiver wanted. Write Hemly WA4UQQ, Savannah, Ga. 31402.

DUMONT OSCILLOGRAPH type 280, complete with manual, mounted in rack on casters. IERC heat transfer meter model 5900 with manual. Details furnished on request. Make reasonable offer for shipment FOB Santa Fe. John S. Catron, W5DZA, 826 Ranchitos, Sante Fe, N. Mex. 87501, 505-982-0894 evenings.

COMMUNICATIONS SPECIALISTS Transmitters-receivers repaired—Kits wired, tested—Custom building—Product detectors added—Receivers updated—By Licensed Engineer—Lab equipment. J-J Electronics, Canterbury, Conn.

APACHE & SB-10, very clean, all manuals, cables and coax relay included. $140 or best offer. Jim Moorman WAØDIC, 1223 Ninth, Ames, Iowa 50010.

SELL: AN/SRT-14 Ø-275 RFO units, AN/FGC-29 NBFSK filters, SASE for list. Need manuals for AN/SR-14 Ø-275 RFO. L. P. Siggen, WØHLT, 512 McDonald Rd., Leavenworth, Kansas 66048.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

SB1-VOX for SBE-33. Operates fine. Came with used SBE-33, and I don't use VOX. Make offer. Will ship post-paid. Miller, 182 Stribling, Charlottesville, Virginia 22903.

BEST BUYS from America's smallest ham dealer. Jerry Hirsch has all major brands and needs used gear, big trades call me last! Hirsch Sales, 219 California Dr., Williamsville, N.Y. 716-632-1189.

MOD 15 TELETYPEWRITER, excellent condx $65. Need Micro-Z-Match, Millen Transmatch, or Johnson Match Box, WA2LIM, 212-428-6133.

---

120 FT. ROHN heavy duty tower. Sell all or part $2.00 Ft. Want Mobile rig. Floyd J. Phillips, WAØJYM, 458 E. 2nd., Russell, Kans.

TRADE, new boxed solid state Ameco .54 to 54MC receiver, performance will surprise you. Need government surplus and tubes. Send swap list. Slep Electronics, Highway 301, Ellenton, Florida 33532.

LAWTON-FORT SILL HAMFEST—February 11, 1968. Contact David R. Tancig WA9FRE/5, 1923 Kinyon, Lawton, Oklahoma 73501.

HAMMARLUND HQ170A. Perfect, original carton, manual. First $235 takes. Failed exam! Theo. B. Younger, 913 St. Marys Ave., Janesville, Wis. 53545.

WHEATON COMMUNITY RADIO AMATEURS (WCRA) will hold the sixth annual Mid-Winter Swap and Shop on Sunday, Feb. 18, at the Du-Page County Fairgrounds, Wheaton, Illinois. Hours—9 AM to 5 PM. $1.00 donation at the door. Refreshments and unlimited parking. Free coffee and doughnuts 9-10 AM. Contact K9GHR, Ken Bourne, 305 Maple St., Glen Ellyn, Ill. 60137.

HAMVENTION will be held Saturday, Feb. 17, 1968, by the Utah Council of Amateur Radio Clubs at the Utah Technical College in Provo, Utah. VHF, DX, ARPSC, MARS, and other group discussions. Special program for the ladies and entertainment for the kids. Contact Bryce K. Anderson K7SAI for registration information. 445 North 300 East, Pleasant Grove, Utah 84062.

MUST SELL: NCX-3 Xcvr and NCXA ac P/S, both excellent $250 or best cash offer (or offers). Gordon Olson, 708 E. 7th, Duluth, Minn. 55805.

HF-VHF-UHF communication and instrumentation products for amateurs. Catalog 25¢ refundable with first order. Mailing list. Radiation Devices Company, Box 8450, Baltimore, Md. 21234.

MOTOROLA new miniature seven tube 455 kc if amplified discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

"ARCTURUS" SALE

• Tube Bargains, to name just a few:

#6146 ....$2.95	#5725/6AS6 .... 59c	#6AQ5 .....56c
#6360 .... 3.50	#5842/417A $2.50	#6BQ7 .....94c
#6688 .... 3.50	#5847/404A 2.50	#6CG7 .....59c
#6939 .... 3.50	#1AX2 ....49c; 5 for 2.00	#6J6 ....49c
#7025 .... .59	#6K7 .....39c; 3 for 1.00	#6T8 ....84c
#7788 .... 3.75	#12BN6 ...39c; 3 for 1.00	#6U8 ....77c
#2D21 ... .49	#25L6 ....59c; 3 for 1.49	#12AU7 ....59c

Any unlisted receiving tube, 75% discount off current list prices.

• Tube Cartons: 6AU6 etc. size, $1.75 per 100. 6SN7 etc. size, $2.10 per 100. 5U3GB size, $2.50 per 100. 5U4G size, .03c each.

• Obsolete Tubes: #UX200, $1.69; #80, $1.20; #10Y, 69c.

• 7 inch 90 degree TV bench test Picture Tube with adapter. No ion trap needed. Cat. #7BP7, $6.99.

• Silicon Rectifier octal-based long-life replacement for 5U4, 5Y3, 5AS4, 5AW4, 5T4, 5V4, 5Z4. With diagram. Cat. #Rect 1, 99c each.

• OZ4 Silicon Rectifier replacement, octal based. Cat. #Rect 2, 99c each.

• 10 Flangeless Rectifiers, 1 amp, 400 to 1000 p.i.v. Cat. #RS10, $2.98.

• 10 Silicon Rectifiers, 750 MA, 50 to 300 p.i.v. Cat. #330F, 99c each.

• Condensers: 50-30 MFD at 150 v., 39c each, 3 for $1.00. Cat. #80; 850-400-100-15 MFD at 16-16-4-115 v., 3 for 79c. Cat. #82Y.

• 2 Silicon Controlled Rectifiers, 1 amp, general purpose units with instructions. Cat. #SCR 1, $1.00.

• 5 Transistor Circuit Boards containing up to 6 transistors, plus diodes, resistors, capacitors, etc. Cat. #TB10, 99c.

• Needles: values such as #AS22 Saphire, 39c; Diamond, 99c

• Color Yokes. 70 Degree for all round color CRT's. Cat. #XRC70, $12.95. 90 degree for all rectangular 19 to 25 inch color CRT's. Cat. #XRC90, $12.95.

• Transistorized U.H.F. Tuners used in 1965 to 1967 TV sets made by Admiral, RCA, Motorola, etc. Removable gearing may vary from one make to another. Need only 12 volts d.c. to function. No filament voltage needed. Easy replacement units. Cat. #U.H.F. 567, $4.95.

• General Electric U.H.F. miniature Transistorized Tuner. G.E. Part #ET85X-33. Cat. #GE85, $4.95.

• F.M. Tuner, Hi-Fi amplifier tuning unit complete with diagram, 2 tubes. Sam's Photofacts #620 lists 2 applications. Cat. #FM20, $3.98.

• Flyback Transformer in original carton. Made by Merit or Todd. Most with schematic drawing of unit. Please do not request specific type. Cat. #506, 99c each.

• Flyback Transformer Kits, 2 flybacks per kit. #502E, Emerson: #502Y, Silvertone; #502W, Westinghouse; #507, Philco; #502, RCA. Any kit $2.99.

• Kit of 30 tested Germanium Diodes. Cat. #100, 99c.

• Kit of 10 NPN Transsistors. Cat. #371, 99c. 10 PNP Transistors. Cat. #370, 99c. All tested.

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TOROIDS—DIODES—COAX—CONNECTORS. 88 mH toroids—45¢ each, 5/$2.00. 1000 PIV 1 Amp Top-Hat Diodes—55¢ ea, 2/$1.00. Connectors, PL259, SO-239, M359—45¢ ea, 10/$4.00. Button feedthroughs (while they last) 500 pF @ 500 V. 20/$1.00. Add sufficient postage. R and R ELECTRONICS, 1953 S. Yellowspring St., Springfield, Ohio.

VARIACS—General Radio and Ohmite. 60 cycles, Input 120V—output 0-280 V. 1 amp or input 240 V —output 0-280 V. 2 amp. PULLOUTS IN GUARANTEED EXCELLENT CONDITION $6.95 plus postage. Shipping weight 10 lb. R & R ELECTRONICS, 1953 S. Yellowspring St., Springfield, Ohio.

32-S3, $525; 516-F2, $75; 75S3, $400; 312-B4, $125; SB-200 linear $175; HO-10 monitor scope $50. 10% off on package deal. K1VCB, Fern Belanger, 61 Lafayette St., Fall River, Mass. 02823.

NATIONAL INCENTIVE LISENSING POLL: Tnx to all who voted. QRM to many who did not. Poll submitted to FCC as you read this. Vast majority against incentive licensing. Final figures soon. Seems hams have not been faithfully represented by any organization. WA2NOD, Box 685, Moravia, N.Y. 13118.

CENTRAL ELECTRONICS 20A like new with 458 VFO, $75.00. HQ-129X with speaker and Q multiplier, $50.00. Dick Acker, W9TOK, 5434 S. Kostner Ave., Chicago, Illinois 60632.

DUMMY LOAD 50 ohms, flat 80 through 2 meters, coax connector, power to 1 kw. Kit. $7.95, wired $11.95, pp Ham KITS, Box 175, Cranford, N.J.

CHRISTIAN HAM FELLOWSHIP now being organized for Christian fellowship and for gospel tract efforts among hams. Christian Ham Callbook for $1 donation. Free details on request. Retired ham desired to run missionary net. Christian Ham Fellowship, P.O. Box 218, Holland, Mich. 49424.

ELECTRONIC PARTS: Components, transistors, diodes, kits, relay and many special items. Guaranteed. Send 25¢ for 100-page catalog. General Sales Co., P.O. Box 2031-F, Freeport, Texas 77541.

WANTED: Military, commercial, surplus. Airborne, ground, transmitters, receivers, testsets, accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

WANTED: Tubes, transistors, lab instruments, test equipment, panel meters, military and commercial communication equipment and parts. Bernard Goldstein, Box 257 Canal Station, New York, N.Y. 10013.

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73

FEBRUARY 1968
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And many more in this Issue

January 1968

Vol. XLVII No. 1

Kayla Bloom W1EMV
Editor

Published by
Wayne Green, W2NSD/1

Cover

Photograph of static electricity as recorded on file. K1GUU.

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $12.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A.

Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

I'm not sure what the typical male reaction will be on finding that the new editor of his favorite ham magazine is a woman. However, I promise to maintain my "cool" and not put a lace border on the magazine. I will continue the present policy of bringing you the best possible articles each month. Keep me in line, fellows, and if I don't give you the kind of magazine you want, let me know.

For a brief backround, I was first licensed in 1956 as KH6CKO, then moved to Denver in 1962 and became WØHJL, and am now W1EMV. I hold a General Class license, but am working toward the Extra at the earliest possible time. My background has been primarily as a wife and mother, but math and physics has constituted a good part of my educational background; mainly in the field of statistics and data processing. I am not an engineer, by any means, but I have done a lot of building and experimenting. When in doubt, I shall consult with someone who has an engineering background. In any case, my husband is gone, my children are grown, and here I am.

So much for the personal side of Kayla. I was one of the "save 11 meters" group, way back when. Since we lost the fight, I have not paid too much attention to what is going on on 27 MHz. Recently, a ham friend with CB equipment let me listen in on the CB band. I was completely stunned by what I heard. Calls like, "This is the 'Barefoot Boy' calling 'Yankee Pirate', come on in 'Yankee Pirate' and talk to the 'Barefoot Boy'." I feel certain these calls were not issued by FCC. Meantime, in the background, many legitimate CBers were trying to get through the QRM to deliver messages which *were* legal on CB channels. One poor company was trying to contact one of his trucks which was located about a mile away, but the long skip was in and a relay was finally accomplished by a station in South Carolina. So much for the efficiency of 11 meters for ground wave when the sun spots rise. The choice of CB frequencies was definitely a mistake.

I wonder what will happen when the sun spot cycle gets to a peak and our CB signals (even the legal 5 watters) begin skipping around the world. We must remember that other countries, especially in South America, still use 11 meters for ham band only operation. I remember in 1958 working a station in Kansas (I was in Hawaii) on 10 meters with less than ½ watt. The CB QRM on ham bands in other countries could lead to an international incident of the first water.

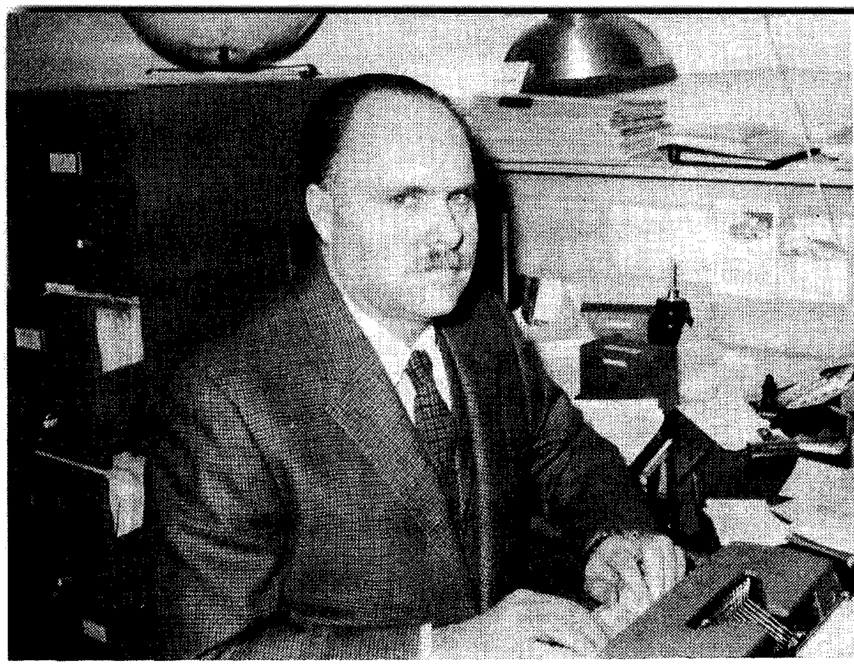
My first reaction to the aforementioned illegal CB operation was absolute horror. Amateur radio gave up 11 meters for this? Then I began listening more closely to our own ham bands, and came to the conclusion that before we throw more stones in the direction of the CB people, perhaps we had better clean our own doorstep.

Disregard for regulations, flagrant violations of the rules, malicious interference, and just plain discourteous behavior seems to be the "in" thing these days. The AM operators who deliberately QRM a SSB round table night after night is only equalled by the SSBers who delight in creating QRM for the AM stations. I feel sure AM will not be eliminated from the amateur bands in the near future, nor do I feel it would be right to eliminate this mode at this time. The two modes are, indeed, incompatible, and we are simply going to have to find a means for peacefully getting along with each other. Continuing to make war on each other is not going to solve any of the problems.

The restricted frequencies created by incentive licensing is not going to improve the situation, so it becomes more necessary for us to find a solution to living together.

The letters column this month has a complaint about deliberate QRM of ARRL's code broadcasts. After reading this letter, I decided to listen and see for myself. I'm afraid the complaint is justified. This behavior is not only discourteous and unjustified, but is highly illegal. On 75 meters recently we have had an influx of "broadcast" stations . . . and I'm not referring to the foreign

(*Continued on page* 73)



de ....
W2NSD

HERE'S WHAT HAPPENED

Subscribers during September and October ran into unreasonable delays on our part. We are trying to make sure that everyone gets every issue they bargained for, but the letters are still coming in from all over the world. While the immediate explanation is programming difficulties with a new computer, the long range explanation is more complicated.

It has been quite a while since I have written about how things are going with 73. A letter from Richard, WB2UMH, asks what happened to some of the old 73 services such as the Radio Bookshop, 6-UP, ATV Experimenter, and the Parts Kits. He also wants to know what has happened to the old aggressiveness of 73.

Perhaps I can put this in perspective if I go back to the beginning.

Ham radio grabbed me during my freshman year in high school, back in 1936. The great bulk of my 35c a day lunch money went into radio parts during high school. I built up a storm and had a wonderful time with my own receivers, transmitters and transceivers. The code bugged me though, and it took several nerve wrenching visits to the FCC before I managed to steady my hand down enough to pass the code test. The only reason I passed, I think, is because I merely went along with a friend who was taking the test and then, at the last minute I decided to give it a try . . it didn't cost anything in those days. It was easy when I wasn't worried about passing and soon I had W2NSD.

A year later came the war. I joined the Navy in '42 and went through what I consider one of the world's greatest electronic schools at Treasure Island. I had joined the Navy with the understanding that when I graduated from school I would go to work for the Naval Research Laboratory in Bethesda, but I changed my mind and volunteered for submarines. During 1943-44-45 I was in the thick of the Pacific war as an Electronic Technician 1/c. Then I was "retired" to New London where I taught school until the end of the war.

After finishing college in 1948 I tried my hand at being a broadcast engineer-announcer at a few stations around the country. Then I got into television, putting WPIX on the air as an engineer and later KBTV in Dallas as a producer-director. It was in 1948 that I got interested in ham-RTTY. I was very interested. When I got a job in 1951 with WXEL-TV in Cleveland as a director I immediately latched onto their mimeo machine and started publishing an RTTY bulletin. By the next year I was writing an RTTY column for CQ.

Television was fast turning to formulas so I decided to get out of that business. Those of you who have read, "Only You, Dick Daring" will understand what is wrong with that industry. I went into hi-fi manu-

facturing and, starting with nothing but a small bank loan, built up a million dollar business in about three years. Unfortunately I am a trusting soul and when the business was incorporated I foolishly did not have my own lawyer check the papers. The other stockholder took over and in about a year managed to bungle the business into bankruptcy. Long before the courts could help me there was nothing to fight over.

On January 5th, 1955 Cowan talked me into taking over the editorship of CQ. The magazine was in bad shape and losing a good deal of money every month. Perhaps I could save it. Inside of a year it was in the black and by the second year it was making a handsome profit, on the order of $100,000 a year.

Cowan and I had our problems. I wanted to change the magazine, dropping the many monthly operating news columns and concentrating on contruction and technical articles. He didn't want it changed. I should have left in 1958 when I realized that it was hopeless, but it is awfully difficult to make a major change like that when you really don't know anything much better to do.

By 1959 things were very bad and on January 5th 1960 we parted company. I went to work with a friend in an advertising agency, but the more I thought about starting a new ham magazine the better the idea sounded to me. In May I quit the agency and rented a little two room office up over a small grocery store in the outskirts of Brooklyn. I bought a mimeo machine for promotion letters and started to work. I tried for three months to find a wealthy ham that was interested in backing the magazine, but no dice. So I sold everything I had that would bring in money and got enough together to put out the first issue of the magazine. I wrote to old friends for articles and started selling subscriptions through radio clubs and at conventions.

The first issue came out in October 1960. It was priced at 37c on the cover and a subscription was $3 a year, $30 for life. In January 1961 I married Virginia and she helped with cutting subscription stencils. I worked about sixteen hours a day, seven days a week. It was over a year before we could afford our first paid employee. We moved the magazine into a small apartment with us in another section of Brooklyn. When our one year lease expired we moved up

(Continued on page 74)

George W. Jones W1PLJ
12 Traill Street
Cambridge, Massachusetts 02138

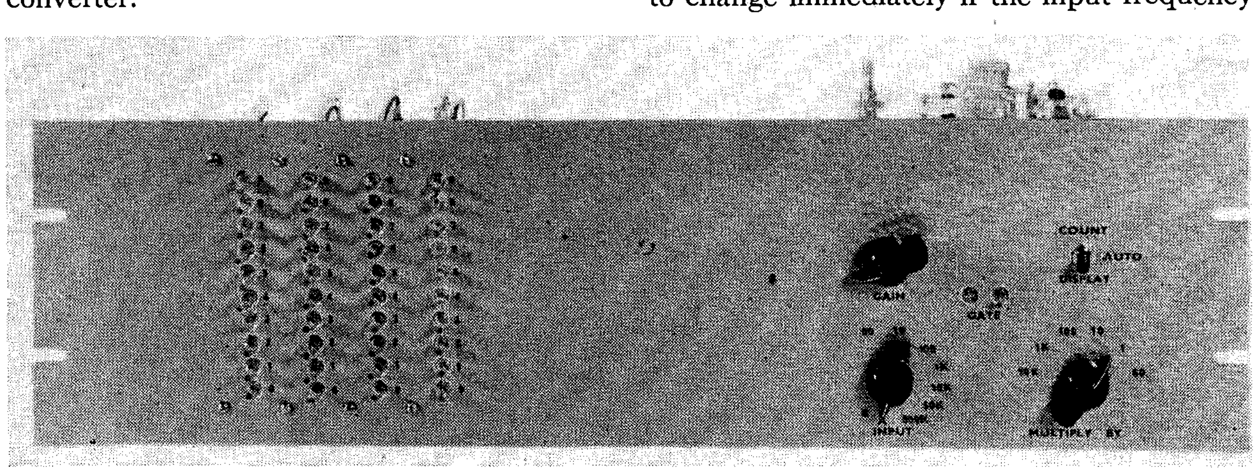
An Integrated Circuit Electronic Counter

Direct Decimal Readout to 10 MHZ

A digital frequency counter is a useful, though not common, piece of equipment in the ham shack. The writer built a counter many years ago using old fashioned vacuum tubes in order to place high in the ARRL Frequency Measuring Tests. The unit only worked up to 100 kHz, but was adequate for the intended purpose. The recent reduction in the prices of plastic encapsulated integrated circuits prompted the writer to see if a better unit could be built with transistors and integrated circuits. The result is a counter which will go up to 10 MHz and has every feature a ham could want, including direct decimal readout and completely automatic operation. The unit shown is useful not only during the ARRL FMT but also in everyday ham operation. During normal operation it is connected to the VFO of my transmitter-receiver setup and is set on the 100 Hz range, thereby acting as a digital "tuning dial" with 100 Hz divisions; a feature not found on any ordinary receiver or VFO. Later, when I go on RTTY, it will be useful for setting the transmitter frequency shift and aligning the receiver converter.

Principles of operation

This counter displays the frequency in decimal numbers so that the operator doesn't have to convert from binary to decimal. On the one-hertz multiplier range, the cycles of the input signal are counted for precisely one second, and the progress of the count can be watched on the neon lamps. The final count is then displayed for one second. The count period can be extended to any multiple of one second if greater than one-hertz accuracy is needed and, likewise, the display can be held for as long as desired. At the end of the display period, the counters are reset to zero and the process starts over again. On the 10-hertz multiplier range the same process is repeated five times a second, on the 100-hertz range, fifty times a second, etc. To avoid confusion on the ten-hertz and higher ranges, the neon lamps are not lighted during the counting period and are, therefore, seen only displaying the final count. On the 10-hertz range, the display blinks five times a second, but on the 100 Hz and higher ranges, it appears continuous and appears to change immediately if the input frequency



Front view of the integrated-circuit frequency counter. The neon counting decades are on the left, count controls are on the right.

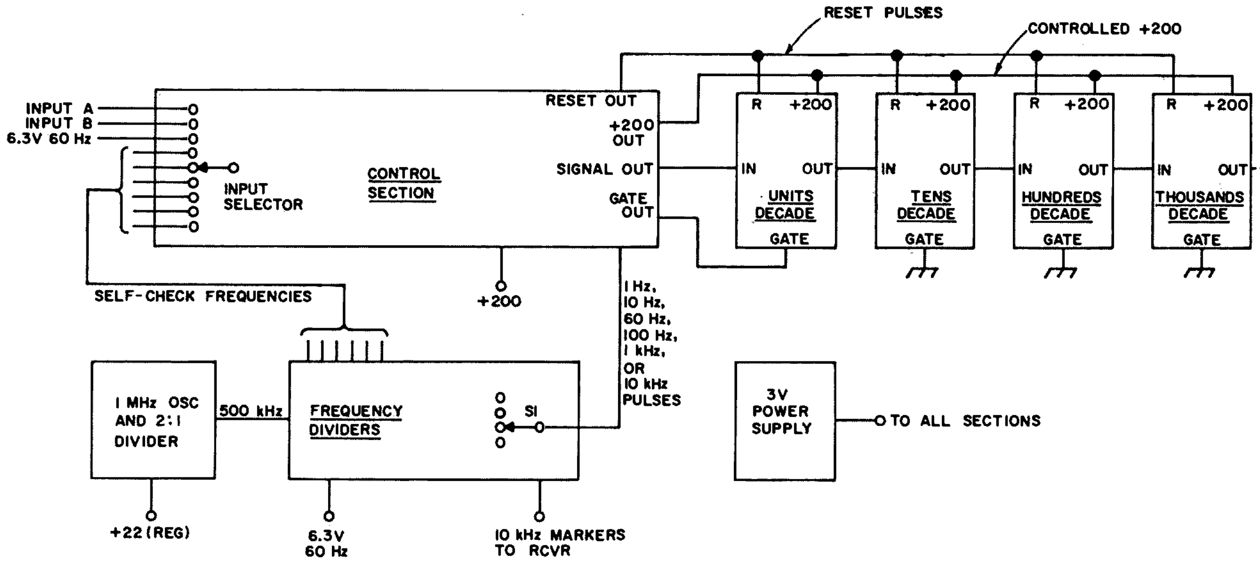


Fig. 1. Block diagram of the complete integrated circuit frequency counter. Any number of decades may be used, but for proper display, the units decade should be to the right, the tens decade to its left, etc.

changes. Therefore, it combines the convenience of an analog display with the accuracy of a digital display. The last digit in this case usually vacillates between two adjacent numbers because of the one hertz per gating period error inherent in a digital count.

The counter consists of three main sections. First, a frequency divider divides the signal from a 1 MHz standard down to 10 kHz, 1000 Hz, 100 Hz, 10 Hz, or 1 Hz, as required. A time base derived from the 60 Hz line could have been used but this would have limited the accuracy to 0.1% and would only have permitted the 10 Hz and 1 Hz ranges. This section also applies 10 kHz markers to the remainder of the frequency measuring setup. The 10 kHz pulses are rectangular in shape and have strong harmonics above 30 MHz. Therefore, they might as well be used as markers.

Second, a control section takes the desired time base frequency and turns on the units counter for the correct length of time. It also shapes the input signal, so that the units counter will accept it, turns on the high voltage supply for the neon lights during the display period, and supplies a reset pulse to all counting decades at the end of the display period.

Third, the counter proper consists of as many counting decades as the builder desires, one for each digit to be displayed. The units decade is gated by the control section and only counts pulses when the control section wants it to. For each ten pulses the units decade is allowed to count, one is passed on to the tens decade, likewise for each ten pulses the ten decades receives it passes one on to the hundreds decade, etc. The decade counters, after the units decade, are not gated since they only receive pulses if the units decade is supplying them. Although the decades count by binary flip-flops, suitable feedback circuits make them count in decimal instead of binary. A decoding network and ten transistors allow one of ten neon lamps on the decade to be turned on to display one digit of the measured frequency. Each decade can also be reset to zero by a reset pulse from the control section.

Digital integrated circuits

The counter uses RTL integrated circuits because of their low cost. These have been described in **73** magazine both in articles and integrated circuits, and in two excellent articles about IC electronic keyers; therefore, they will only be described briefly here. The reader who is not familiar with RTL circuits should review these references before trying to understand the counter in detail. He might also find it advisable to build the "Kindly Keyer", before he builds the counter, as the writer did. Although the counter could probably be built and made to work by just following the diagrams, a previous knowledge of RTL circuits, gained by building a simpler device, will help in trouble shooting.

Oscillator and frequency dividers

A 1-MHz crystal oscillator is used as the main frequency standard at W1PLJ. One MHz is used instead of the usual 100 kHz because a 1-MHz crystal gives better stability than a 100-kHz crystal if one wants to pay a reasonable price for the crystal. This is probably because the 1-MHz crystal can be AT cut. The oscillator and a divider to 500 kHz are mounted in a separate box so that the oscillator can be kept on all the time for better stability. Also, 500 kHz can be used for other purposes including future plans to use it to synchronize a phase-locked oscillator for the first conversion of the receiver. If the builder already has a frequency standard, it is not necessary to build another crystal oscillator for the counter—the existing one can be worked in easily. Conversely, if the builder is interested in frequency measurement but does not yet want to build the counter, he can build the oscillator and the dividers down to 10 kHz and at least have markers for his receiver. The oscillator and first divider are shown in **Fig. 2.**

The remainder of the frequency divider section, **Fig. 3**, consists of 2:1 and 5:1 dividers. The 2:1 dividers are simply J-K flip-flops; the 5:1 dividers are J-K flip-flops with an RC network and inverter on the set input which only allows every fifth input pulse to produce an output pulse.

The 5:1 divider can be best understood from the diagram and waveforms of **Fig. 4.** Without an input signal, the inverter input is held high by the connection to positive voltage thru R_1. The inverter output is, therefore, low so that low appears on the set input of the flip-flop. If the O output of the flip-flop is initially high, the first negative going transition on the toggle input will make it go low. This change will be passed on to the inverter through C_1 and this will make the set input go high so that the O output cannot go low again when more input pulses come in. C_1 will charge through R_1 and, after a delay, the inverter output and the set input will go low again so that the flip-flop can respond to an input pulse. If the divider is adjusted correctly, it will pass every fifth input pulse. Other division ratios can be obtained, and maybe it would work with a division ratio of ten, but the ratio of five makes the division ratio very stable. In fact, it does not go out of adjustment for a change in the supply voltage from 3.0 to 4.0 volts.

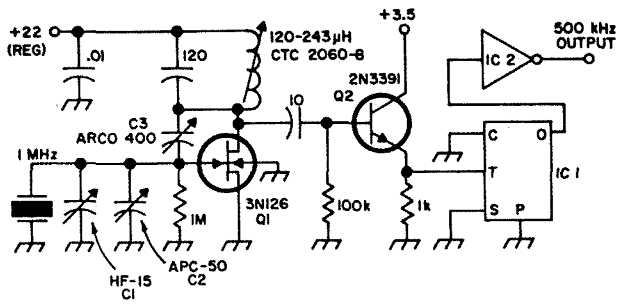


Fig. 2. The oscillator and 2:1 frequency divider used with the decimal counter. This unit was built into a separate box and may be used for obtaining markers as described in the text. Although the FET is a Motorola 3N126, an MPF-105 is less expensive and would probably work. IC1 is a Fairchild 923 or one-half a Motorola MC-790-P; IC2 is a Fairchild 900 or one-half of a Motorola MC-799-P.

The first three 5:1 dividers are identical except for time-constant values. The output of the 10-kHz divider is fed through a buffer to the station receiver and frequency measuring equipment. The markers are very strong through 30 MHz, the limit of the author's receiver. If the receiver calibration cannot be trusted to 10 kHz, the 50-kHz test button, shown in dotted lines in **Fig. 2** and not used by the author, can be provided. Pushing this button makes the 50-kHz markers louder and the other 10-kHz markers turn into 25-kHz markers. The counter proper does not read correctly while this is being done, but this doesn't matter since identifying the markers is done separately from making the final count.

The divider form 500 Hz to 100 Hz uses a discreet high-beta transistor instead of a gate, so that a higher resistor value and, therefore, a smaller capacitor value can be used. The dividers to 10 Hz and 1 Hz use decade dividers, with four J-K flip-flops in order to avoid even larger capacitors. This type of circuit could have been used for all the dividers and would have eliminated the need to adjust the dividers. The circuit of these dividers will be described in the section on the counting decades which use the same circuit.

The switch, S_1, selects the divider frequency whose period is equal to the desired gate time and is calibrated in factors, by which the counter reading must be multiplied, rather than in gate time. The X60 position takes the time base from the ac line instead of the dividers, and is useful in adjusting the dividers. For example, to adjust the divider whose output frequency is 50 kHz the input switch is set to 50 kHz, the multiplier

switch to 60 and the counter should read 833. This reading will jump around a bit, due to instability in the ac line frequency, but the reading for the 10-kHz divider will only vacillate between 166 and 167.

Control section

The input selector switch, S_2 (Fig. 5), selects the desired input which can be either a signal input for measurement, or one of the divider outputs for self checking. IC_8 and IC_9 can be regarded either as an amplifier with positive feedback, or as a flip-flop. They make the signal into a rectangular wave with sharp edges and reject noise which may appear on the input signal. At any instant of time, either IC_8 or IC_9 will conduct, but not both at once, because the one that is conducting turns the other one off. The positive half cycle of the input signal will make IC_8 conduct and once it is turned on, the high output from IC_9 will supply holding current through R_4 to keep it on.

The negative half cycle will then overcome this holding current and turn off IC_8 whereupon the holding current will be removed and IC_8 will continue not to conduct. A small amount of noise riding on the input signal will not be able to overcome the holding current and will, therefore, not make the circuit change state. The resulting rectangular wave is fed to the units decade at all times and the necessary gating is done in the first J-K flip-flop of the units decade. Provision for gating already exists in the J-K and it is simpler to use it than to do the gating in the control section.

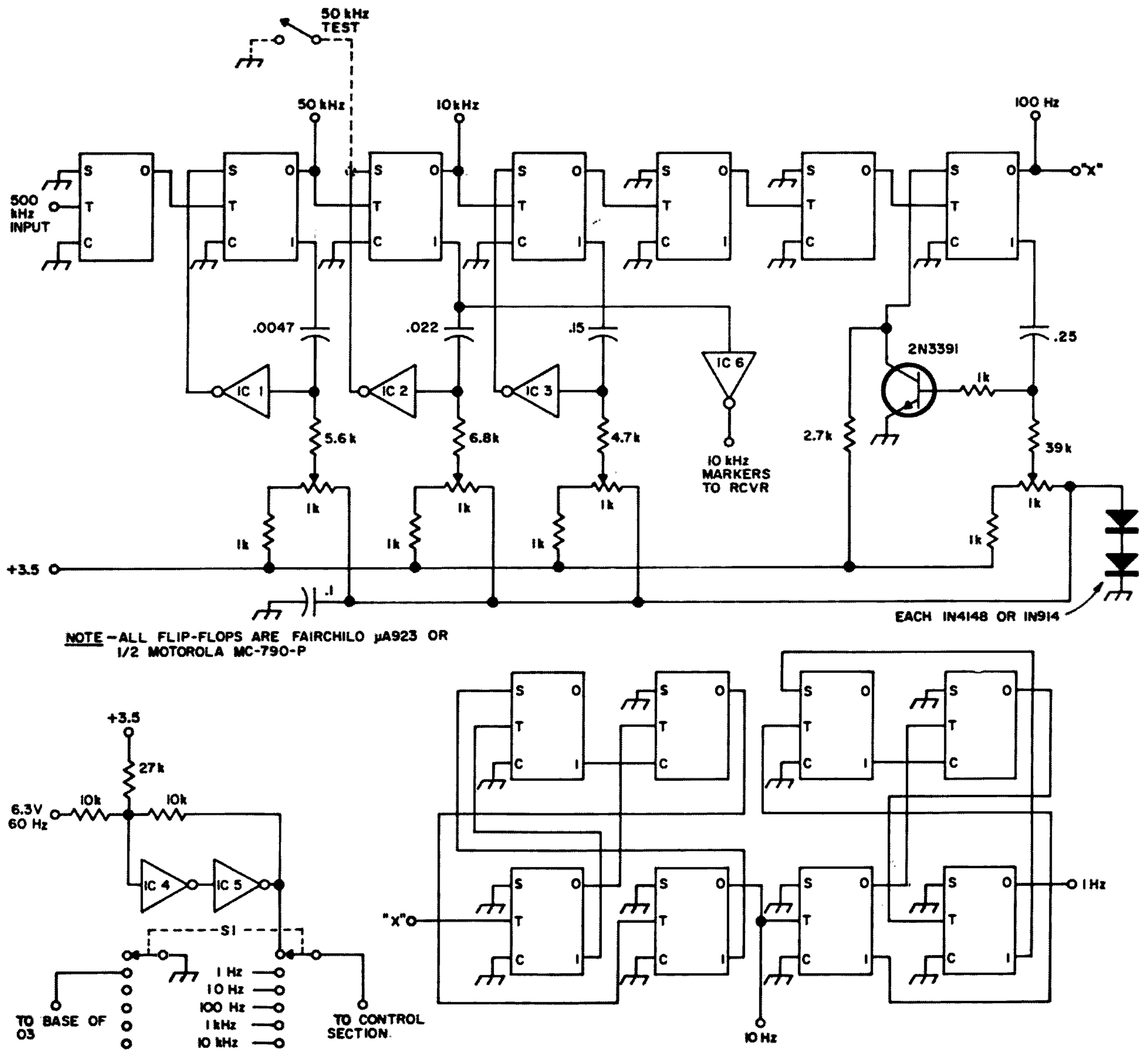


Fig. 3. The frequency dividers used in the IC counter. Integrated circuits IC1 through IC5 are one-half of Fairchild 914's or part of Motorola MC-789-P or MC-724-P; IC6 is a Fairchild 900 or one-half a Motorola MC-799-P.

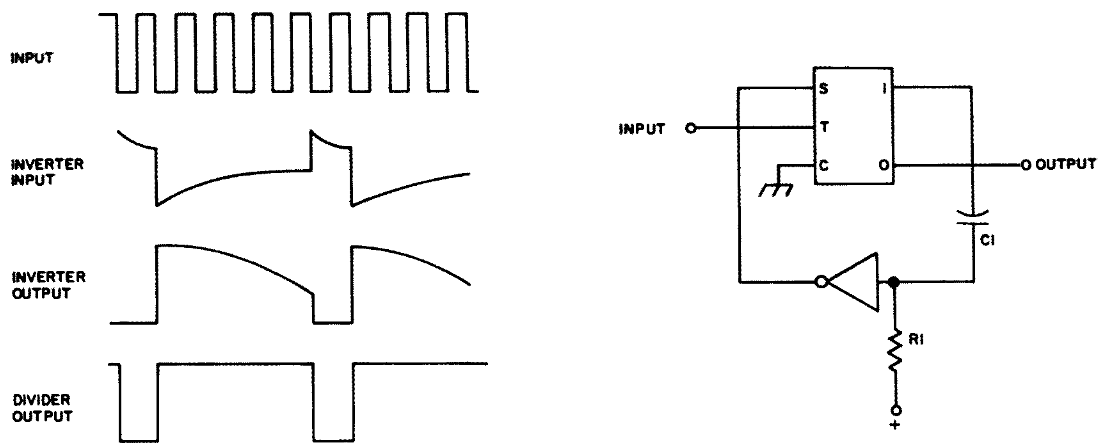


Fig. 4. The basic 5:1 frequency divider using a J-K flip-flop, and RC circuit and an inverter, along with the waveforms.

The remainder of the control section can exist in either of two states, count or display. We will discuss these quiescent states before we examine how it gets from one to the other. In the count state the 1 output of IC_7 is high and the O output is low. If S_1 is not in the X1 position, the high 1 out-put of IC_7 turns on Q_3 and turns off Q_4, thereby turning off the neon lamps. The low O output of IC_7 goes to the gate input of the units decade and allows it to count. It also turns off Q_1 so that the "gate on" light will be illuminated and it per its the "gate pulse" light to be turned on if a gate pulse is present. The opposite conditions exist in the display state. Power is applied to the neon lamps through Q_4, and a high output is supplied to the gate so that further counting cannot occur, and both Q_1 and Q_2 are turned on so that the two gate lamps are shorted and not illuminated.

To understand how we change state, assume we are on display and S_3 is in the automatic position. IC_1 and IC_2 form a monostable multivibrator which supplies the reset pulse and the trigger for IC_7. The positive-going edge of the rectangular wave from the frequency dividers turns on IC_1 momentarily and this makes the output of IC_2 go high. Furthermore, this holds IC_1 on until R_2 charges up C_2 again, whereupon the output of IC_2 goes low again. The result is a short pulse which occurs once every timing period. Since we are on display and automatic, this pulse will be passed by IC_3, IC_4, IC_5, and IC_6, inverted each time, and appears as a high pulse to reset the counters. The trailing edge of the pulse from IC_2 will toggle IC_7, putting us in the count mode. The next pulse from IC_2 will not reset the counters because IC_4 has a high input from IC_7 and, reset can only occur if all three inputs to IC_4 are low. The trailing edge of the pulse still toggles IC_7, however, and we are in the display mode; displaying the number of input pulses that occurred between two timing pulses.

The switch, S_3, is used if you want to count, or display, for a multiple of the basic timing period. The switch itself does not switch the counter to display or count, since only the timing pulses can be allowed to do this; rather, it prevents the counter from going into the other state. The "display" position of this switch is useful if you have just made a critical count and want to hold it a few seconds to make sure of writing it down correctly. It is also useful if the circuit for blanking the neon lamps isn't working or isn't yet built and you want to make a reading on the higher ranges. In this case it is difficult to read the display on the automatic position because you will see both the counting and the display, but placing S_3 on "display" will hold the last count and allow you to read it. The switch can be thrown to "display" either during count or during display. In either case, a timing pulse will still switch IC_7 from count to display at the right time, but the next timing pulse will not put it back on count due to the high level on the clear input. Also, the counter will not be reset due to the high input of IC_4 which will hold its output low.

The count position of S_3 is normally used only on the XI position of S_1, and is used when you want a gate time of several seconds for an error of less than one Hz. This is useful in the ARRL Frequency Measuring Tests where it is desirable to use a 10-second gate time in order to obtain an accuracy of 0.1Hz. With this arrangement,

if you start a ten second run and the signal starts to fade, you can stop the test at the next timing pulse by throwing the switch to display and still obtain a meaningful reading. To make a ten second run, you start with S_3 on display, and throw it to count when everything is ready. The next timing pulse will put you in the count mode, but the next one will not put you back on display.

Each timing pulse will flash the "gate pulse" lamp once, and after it has flashed ten times, you put S_3 back on display. The next pulse will put the counter on display and you will be able to read the frequency in tenths of hertz. With a little practice, you will find that running a multiple second count is much easier than reading about it.

In wiring the counter it should be remem-ered that the supply to the neon bulbs is a 200-volt square wave because of the lamp blanking circuit, and also, the collectors of Q_1 and Q_2 (Fig. 5) have 60-volt pulses on them since they turn on neon lamps. Both of these must be kept away from the inputs to the IC's; otherwise, erratic operation will result. In particular, the 200-volt lead to the counters must not be cabled with the signal and gate inputs to the counters and the leads to I_1 and I_2 must be kept at least an inch away from the leads of S_3. If the counter shows any erratic operation which cannot

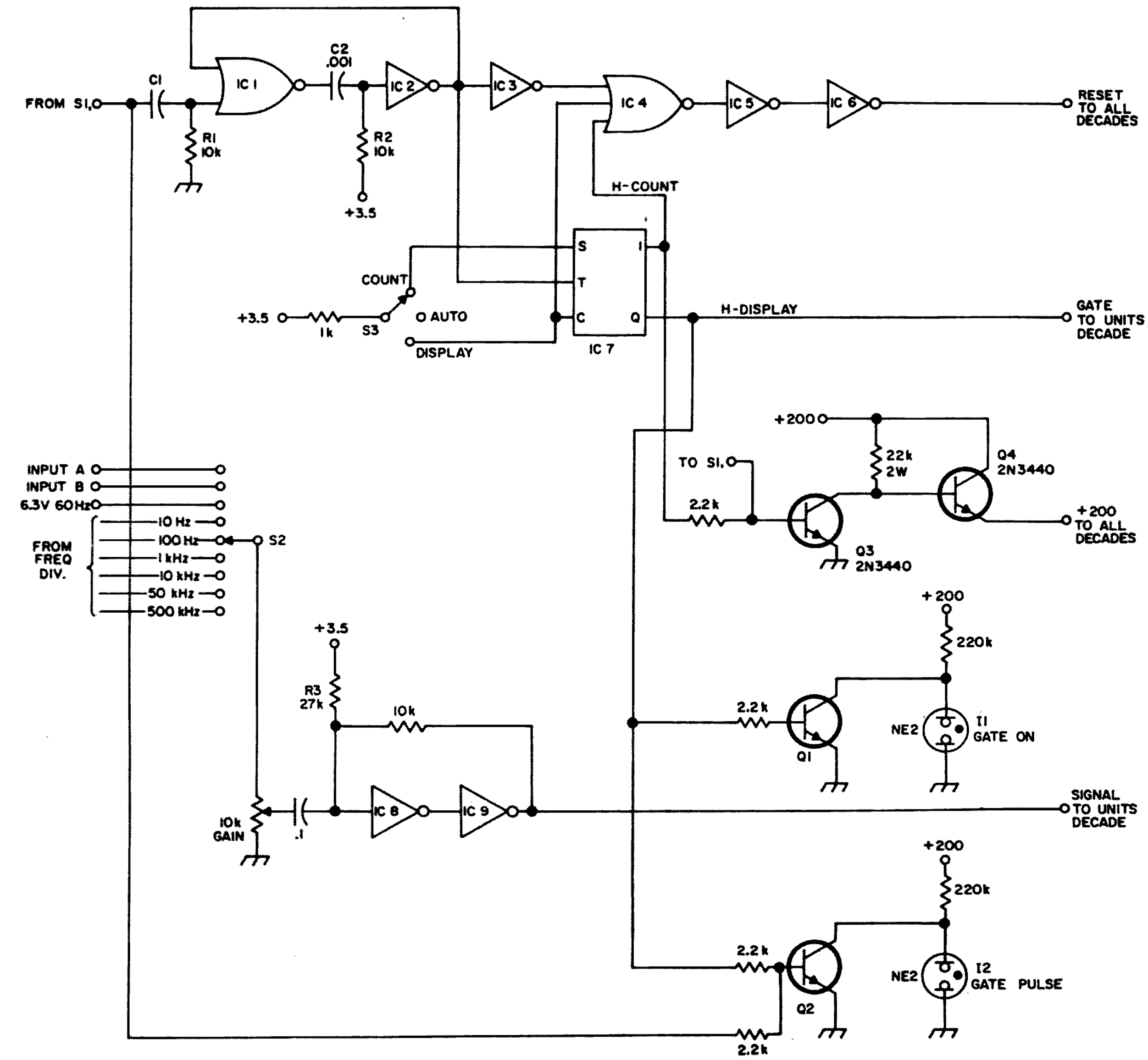
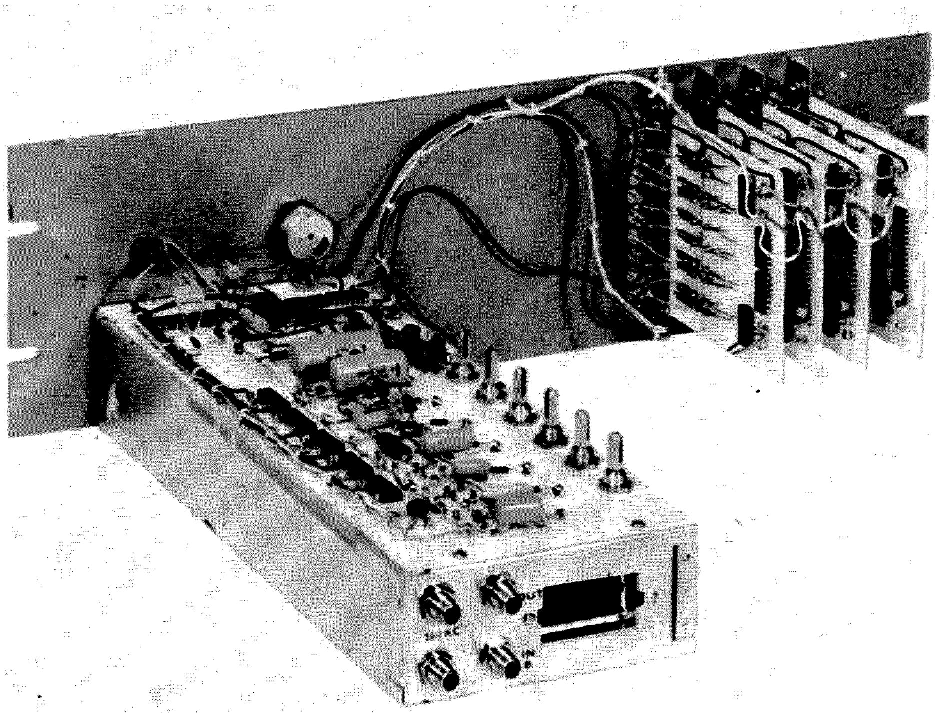


Fig. 5. The control section of the digital frequency counter. IC1 is a one-half a Fairchild 914, one-fourth a Motorola MC-724-P or one-third a Motorola MC-792-P. IC4 is one-third a Motorola MC-792-P. IC2, IC3, IC5, and IC9 are one-sixth of Motorola MC-789-P, one-fourth of Motorola MC-724-P, or one-half of Fairchild 914. IC6 is a Fairchild 800 or one-half a Motorola MC-799-P. IC7 is a Fairchild 923 or one-half a Motorola MC-790-P. Q1 and Q2 are 2N3877's or Poly Pak 2N1893's.



All of the count-control circuitry is mounted on the large chassis to the left. The small perforated boards on the right each contain one decade counter.

be easily explained, the blanking circuit should be disabled by grounding the base of Q_3 so that the lamps are on continuously, and I_1 and I_2 should be shorted to ground. A test can then be made to see if the trouble still exists. Except for these precautions, no other difficulties should be encountered with the unit.

Counting decades

Fig. 6 shows the circuit on one counting decade, including neon lamp drivers. The gate input on the units decade is connected to the gate output of the control section, but the gate inputs on the other decades must be grounded since each must accept any pulses put out by the preceeding decade. The actual counting is done by four J-K flip-flops and, with the help of the table shown, the reader can follow the count as an interesting exercise. The input pulse following the ninth count makes the decade go back to zero and passes a negative transition on to the next decade making it count once.

IC_5 through IC_{12} are needed to amplify the voltage output of the J-K flip-flops. The J-K's give only one-volt output with light external loading due to the fact that they internally load their own outputs. This was not found sufficient to drive the resistor gates used for the neon lamp drivers. An inverter, however, gives almost full supply voltage when lightly loaded and drove the resistor matrix satisfactorily.

It is necessary to use discrete transistors to drive the neon lamps at the present state of the art, but these are not expensive, expecially if Poly Paks* 2N1893s are used. The transistors are used as shunts scross the lamps. This makes gating simpler and also limits the voltage across each transistor. For a given count one lamp must be on and the other nine off. The driver for the desired lamp must have low level on all its inputs so that the transistor will not conduct, allowing the lamp to light. The other nine drivers must have high level applied to at least one input; this will be sufficient to extinguish the lamp, regardless of what appears on the other inputs. The gating of the lamps could have been done entirely with IC's but this method was found to be simpler and cheaper, at least at the present state of the art.

Count	A B	B A	C D	D C	E F	F E	G H	H G
0	H	L	H	L	H	L	H	L
1	L	H	L	H	H	L	H	L
2	H	L	L	H	L	H	H	L
3	L	H	L	H	L	H	H	L
4	H	L	L	H	H	L	L	H
5	L	H	H	L	H	L	L	H
6	H	L	H	L	H	L	L	H
7	L	H	L	H	H	L	L	H
8	H	L	L	H	L	H	L	H
9	L	H	H	L	L	H	L	H

Table 1. Truth table showing the proper levels on each of the logic lines of the decade counter in Fig. 7.

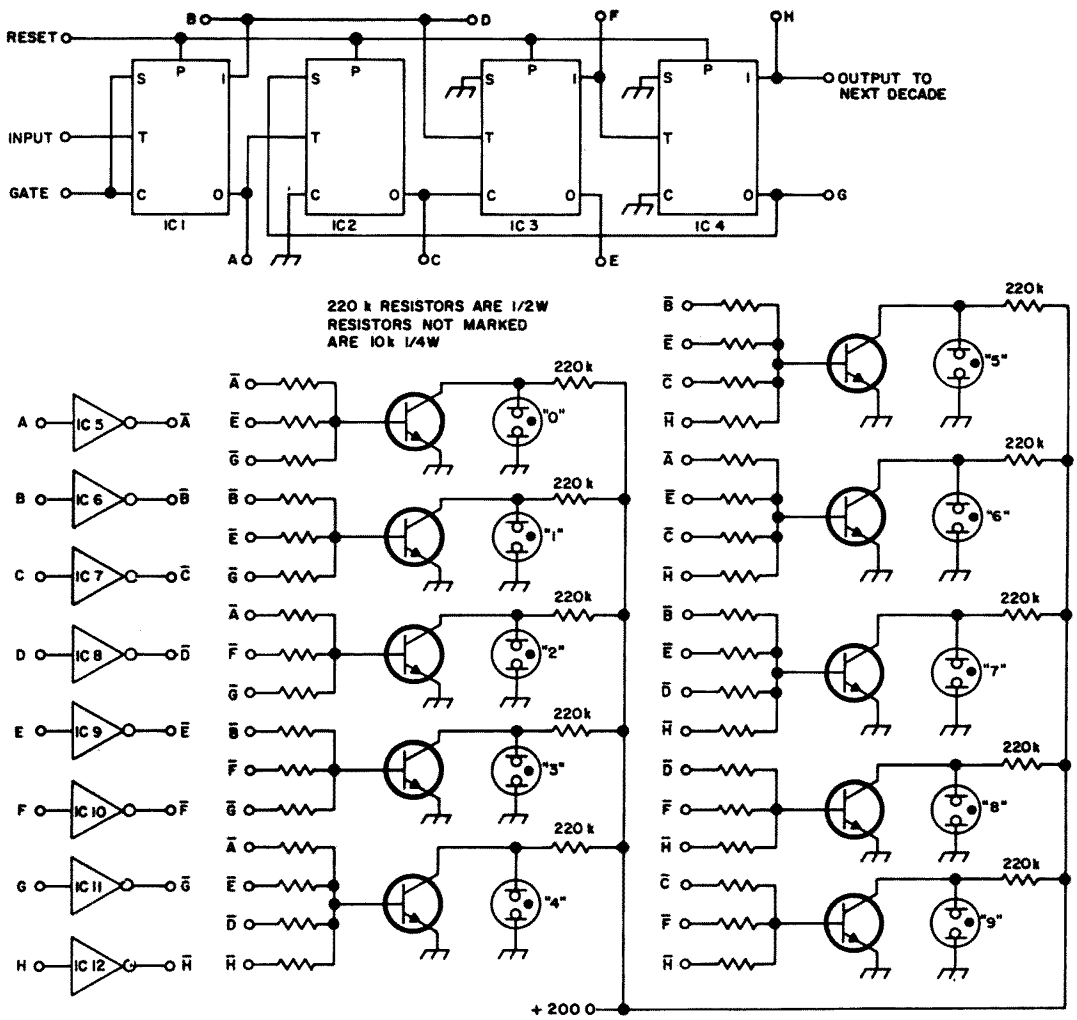


Fig. 6. A typical counting decade. In this circuit integrated circuits IC1 through IC4 are one-half Motorola MC-790-P's or Fairchild 923's. IC5 through IC9 are one-sixth Motorola MC-789-P's, one-fourth Motorola MC-724-P's or one-half Fairchild 914's. All transistors are 2N3877's or Poly Paks 2N1893's. All neon lamps are NE-2's.

In testing the decades, +200 volts must not be applied unless all transistors, which are in place, have neon lamps across them. Otherwise, if a transistor is not conducting, the collector voltage rating will be exceeded since there is no neon lamp limiting the voltage. Also, if +200 volts is applied to a decade but +3.5 is not, all lamps should light since the logic circuitry only acts to short out the undesired lamps. No harm is done by this and it is a quick way to check the lamps and driver transistors. If a lamp does not light under this condition, its driver transistor should be suspected first.

Power supply

The counter, as shown in **Fig. 6**, requires about one ampere at 3.5 volts and 40 mA at 200 volts. Neither supply needs to be regulated and the IC's will work on any voltage from 3.0 to 4.5 volts, although 3.6 ±10% is recommended by the manufacturer. The power supply used by the author is shown in **Fig. 7.** An 8-amp transformer was used because it didn't cost much more than a 2-amp one in the same series. The 2-amp unit would probably work and would save space and weight. For the 200-volt supply, anything from 150 volts on up would work, although with anything much over 200 volts, the 220K collector resistors must be increased or a dropping resistor must be provided. If this voltage is taken from a supply powering other equipment, it must be remembered that the current drawn will be a 40 mA peak square wave at 5, 50, 500, or 5000 Hz which may cause a buzz to be heard on the other equipment.

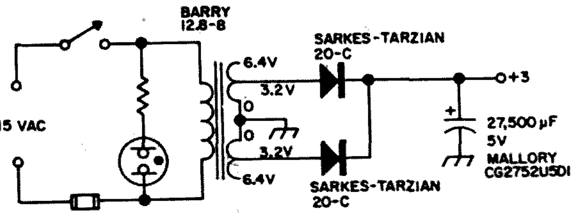


Fig 7. Three-volt power supply for use with the integrated circuit frequency counter. A truth table showing the proper levels on each logic line are shown in Table I.

Construction

The individual counting decades are built on See-Zak MM-492 boards and the remainder of the unit on a See-Zak MM-512 board mounted on See-Zak R-25 and R-212 rails. See-Zak M-25 terminals are used for the larger components, including the Fairchild IC's. The hole spacing on these boards is 0.2" whereas the Motorola IC's require 0.1" spacing; therefore, seven extra 1/16 inch holes must be drilled for each Motorola IC inbetween existing holes. Connections to the Motorola IC's are made with #26 bare wire covered with Teflon spaghetti. No other construction details are given since the writer is more interested in circuitry than packaging and other builders will probably have ideas of their own. The use of printed circuits would be ideal.

. . . W1PLJ

*Poly Packs, Post Office Box 942A, Lynnfield, Massachusetts 01940.

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2. Brassine, "An Electronic Counter for Amateur Use," *73*, December, 1966, p. 20.
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HOW COME?

I have two cubical quad beam antennas in my yard. Each is on a forty foot tower. They are separated by about eighty feet. Hundreds of times I have tuned in a signal on the two element quad, measured it with the S meter, and then flipped the co-ax antenna selector switch to the four element quad, and again measured it. The difference in the S meter reading is usually one S unit, or, according to the usual calibration of S meters, about six dbs. This, I suppose, is what it should be. A Collins and a Swan were used in measuring. Remember, both quads are identical in construction, measurements, height, and closeness to foreign objects.

The only difference between the two is that the 4 element quad uses two directors and the two element quad uses no directors. Now, I can switch to transmit, and contact many stations. These amateurs almost invariably report the signal from the 4 element quad from two to three S units greater than on the two element quad. This is from twelve to eighteen dbs.

Obviously there is not that much difference in the two antennas, so where does the extra punch of the four element quad come from? The difference between the four and the two element quad will almost invariably measure this amount, regardless of the type of receiver the amateur is using.

How can we account for this difference? Is it the vertical angle of radiation? Is it the aperature, or the capture area? Is it a combination of several factors?

One thing is obvious. If we put 100 watts, let us say, of r.f. energy into an antenna, it will be distributed in various ways. If the antenna is a vertical, it will be distributed equally in all directions. If it is a beam antenna, then a certain direction will be favored. The greater the F/B ratio, the greater the gain in a certain direction. We cannot get something for nothing. We have to take it off the back if we want to put it out front. Then there is the actual "cone" of the radiation pattern. A two element quad possesses a much broader cone than a four element quad. Hence the actual energy is concentrated in the favored direction much more in the four element quad than in the two element quad. This is apparently not true in the reception of signals. Evidently the old adage that "A good receiving antenna is an equally good transmitting antenna", is not entirely true. In our case, it would appear that, even for a quad, it can be a better transmitting antenna than a receiving antenna.

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An Amateur Tries I C's

There is no doubt that the greatest advance in electronics since the transistor is the integrated circuit, where a dozen or more transistors, resistors, and diodes are put in a can no larger than a single transistor. The whole lot in fact on a little chip of silicon less than an eighth of an inch across. Perhaps the day of Dick Tracy's wrist watch size radio is almost here.

Heath has already announced kits using these circuits, and other manufacturers are undoubtedly thinking along the same lines, so it behooves the experimentally-minded amateur to learn something about this latest development.

There have been some excellent articles in *Electronic World*, *Radio Electronics*, and *73*, which should certainly be consulted, as well as the manufacturer's literature. The RCA specification sheets and application notes are particularly instructive. My indebtedness to the above sources is gratefully acknowledged.

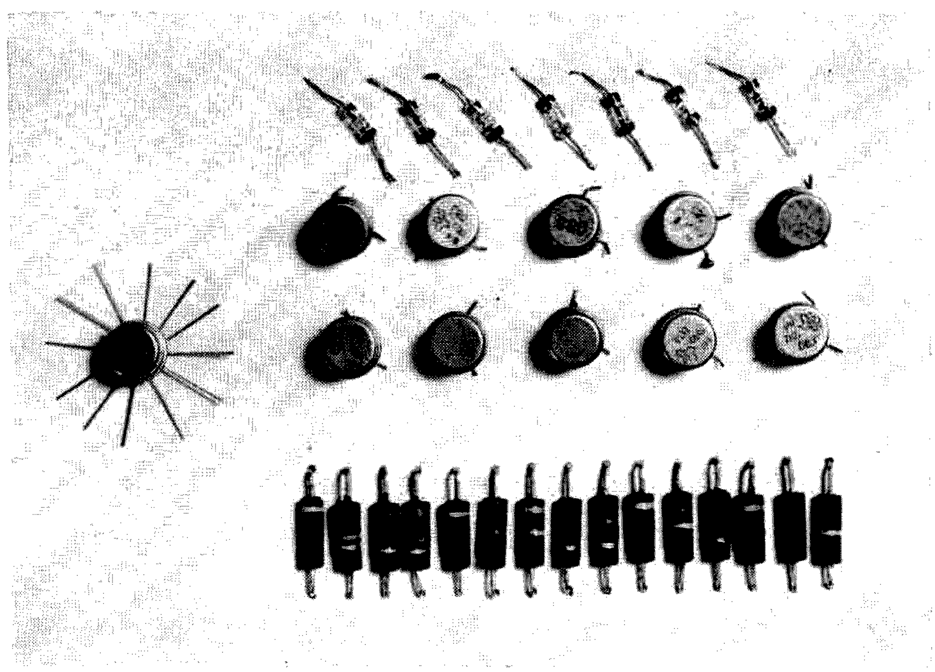
One of the first confusing things about IC's is the use of transistors to replace capacitors; this gives the circuit a strange and unfamiliar look which takes a while to get used to.

It would be impossible to incorporate large capacitors or resistors on the small chips, so transistors are used instead. Where large capacitors or resistors are necessary, they are connected externally, as are coils and transformers.

The most commonly used arrangement in the linear integrated circuits, is the emitter-coupled pair, with the emitter current supplied by another transistor. The input is usually differential and the output may be single ended or push-pull.

This approach would be impractical with individual transistors, but because all the components are on the same piece of silicon, their characteristics are similar and are closely matched over a wide temperature range. The basic system is shown in **Fig. 1.**

One of the simplest IC's and the easiest to understand, is the Fairchild μA 703 C (or μ7703 as it is now designated). Incidentally, there seems to be some disagree-



This photograph dramatically illustrates the number of transistors, resistors and diodes incorporated in one RCA CA 3012 integrated circuit. The CA 3012 IC is shown on the left for comparison.

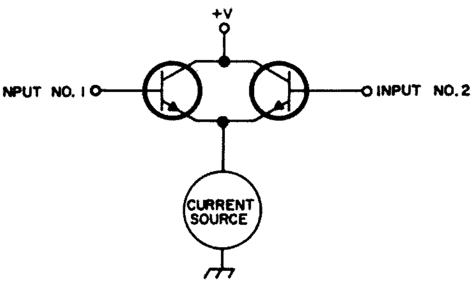


Fig. 1. The basic emitter-coupled pair. This approach is difficult with discrete transistors, but with the IC, all the components are on the same silicon chip, and their characteristics are similar and remain matched over wide temperature ranges.

ment on the numbering of the pins. The numbering used here is from the Fairchild specification sheet dated August 1966 (**Fig. 3**).

The μ7703 is classed as an rf and *if* amplifier and is one of the least expensive of the Fairchild IC's at about $4.50 each in small quantities. A diagram of the μ7703 is shown in **Fig. 3.** As will be seen, there are two additional transistors connected as diodes; I don't think we need to go into the theory behind them, but can use the simplified diagram for our purpose. For further technical information see the references. Although the μ7703 is listed as an *if* and rf amplifier, it can also be used as a dc amplifier.

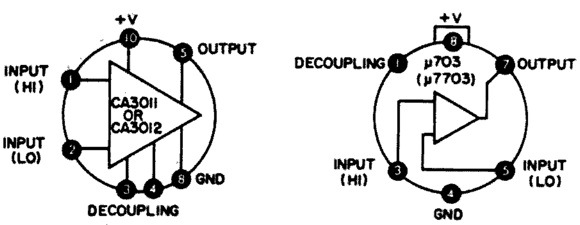


Fig. 2. External connections to the Fairchild μ703 (μ7703), and RCA 3011 and 3012. The internal circuit of the μ703 integrated circuit is shown in Fig. 3; the CA 3012 is shown in Fig. 4.

For experimental purposes the μ7703 was mounted on a small piece of bakelite. Double-ended Cambion 2044 terminals which (as they always say in radio articles) I just happened to have a thousand of in the junk box, were forced into slightly undersized holes in the board so that it wasn't necessary to use special setting tools. The IC was soldered to these pins and the wiring was done underneath.

The μ7703 has a rated working voltage of 12 volts but the first one blew on 9½ volts, so a limiting resistor was used in the power supply and the current was kept below 3 mA. A look at the chip in the dismantled IC makes one wonder how they can handle any power at all! The chip doesn't seem to be much larger than the head of a pin and a high-power glass is needed to see the actual components.

To familiarize myself with the μ7703 and to be sure of not overloading it, I used a Weston photoelectric cell in the input. A few microamps in gave an output in the milliampere range. Using a tuned-input circuit, it became a very sensitive absorption meter.

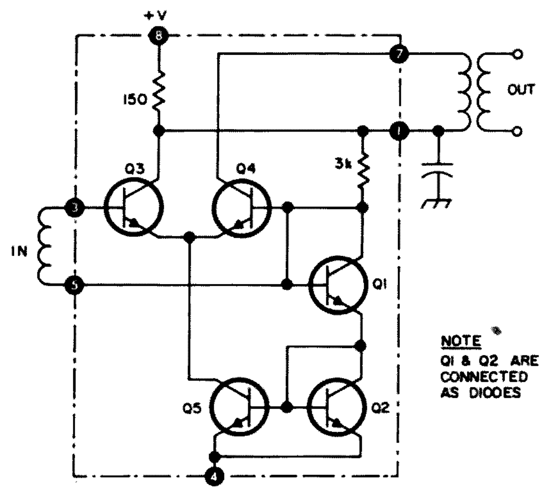
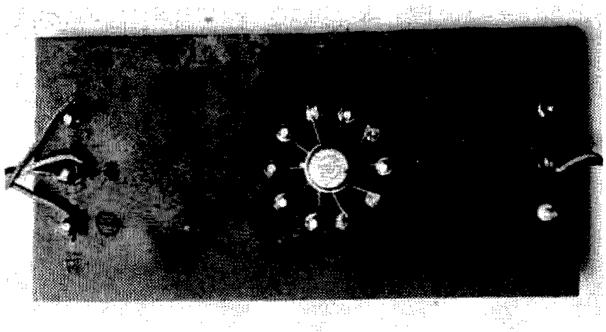


Fig. 3. The circuit of the Fairchild μ703 (μ7703). Basically, this is an emitter-coupled pair (Q3 and Q4) with a constant current source (Q5). Transistors Q1 and Q2 are connected as diodes.

Just looking at the RCA 3000 series of IC's makes one drool and wish for a pocket full of cash to get the whole series. The only trouble is that they seem to be in short supply. I have been waiting for months for some I ordered from Chicago and they haven't arrived yet.



The test setup used for checking out the capabilities of the RCA 3012 integrated circuit.

Type	Circuit Application	dB Gain	Freq. MHz	MfC	Price	Noice dB
CA 3000	Differential Amplifier	37	30	RCA	$4.70	—
CA 3001	Differential Amplifier	19	video	RCA	$6.40	5
CA 3002	Differential Amplifier	24	*if*	RCA	$4.40	4
CA 3004	Differential Amplifier	12	100	RCA	$4.40	6.3
CA 3007	Differential Amplifer	22	audio	RCA	$6.00	—
CA 3011					$1.55	
	Wide band Amplifier	75	20	RCA		8.7
CA 3012					$2.25	
	Wide band Amplifier	75	20	RCA	$2.65	
CA 3014	Discriminators	75	20	RCA	$3.15	8.7
CA 3020	AF Amplifier	58	6	RCA	$2.80	—
CA 3021		56	2.4		$3.60	4.2
	Low Power Wide band					
CA 3022		57	7.5		$3.15	4.4
	Amplifiers					
CA 3023		53	16	RCA	$2.95	6.5
CA 3028	RF Amplifier	39	120	RCA	$1.55	6.7
μ7703	*IF* Amplifier	41	—	Fair-child	$4.10	—

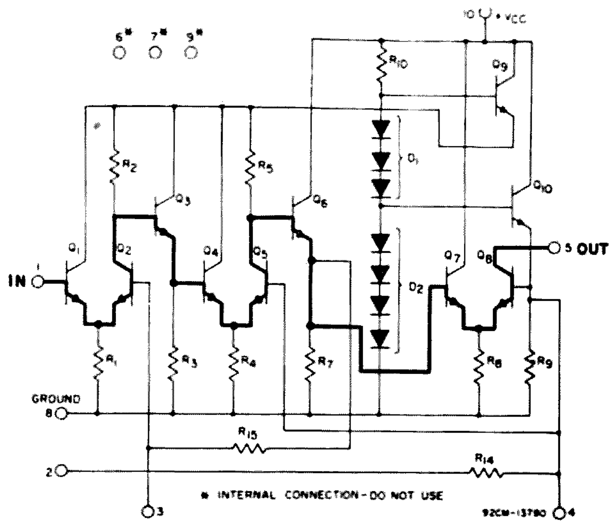


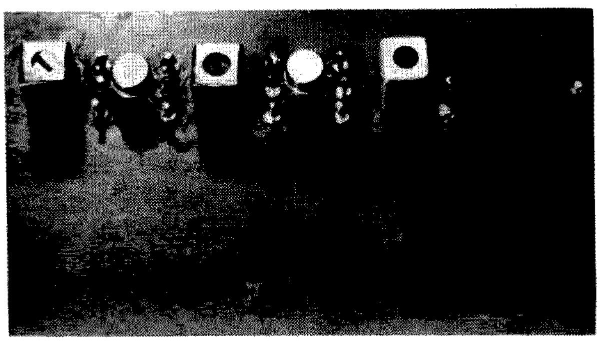
Fig. 4. Internal circuit of the RCA CA 3012 integrated circuit. The signal path through the unit is shown by the heavy line.

Only the larger industrial stock houses seem to be handling the IC's, and the types stocked are for the large users for defense and computer purposes. The RCA line seems to be the lowest priced and most complete of any.

I was able to get a few RCA CA 3012's locally so an *if* amplifier was constructed using two of these. I had planned on using IC's in the converter and audio amplifier, but I had to settle for an imported audio amplifier and a transistor converter. I also made an *if* amplifier using Fairchild μ7703's. The μ7703, because of its fewer pins, was easier to work with and needed fewer components. After making these up, I discovered 7- and 9-pin connectors for miniature sockets which would have made it easier to interchange IC's.

As this was a preliminary project to see how well IC's worked, no refinements were considered; they will come later. The results obtained with these little jewels were truly amazing.

. . . VE3DAN



An *if* amplifier and detector built from two Fairchild μ7703 integrated circuits. There is enough room left on the board for an audio amplifier.

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The Ferris Wheel Antenna for 160- and 80-Meters

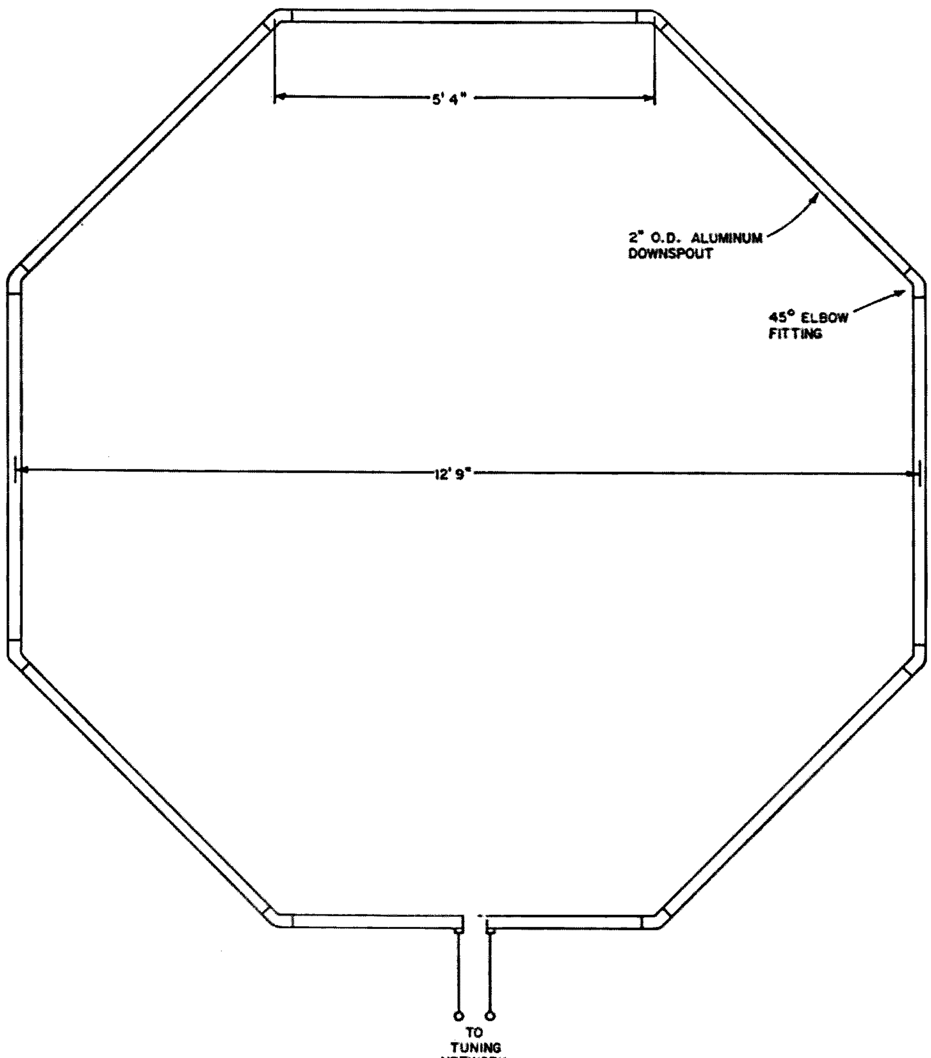

Fig. 1. A Ferris Wheel antenna cut for 160 and 80 meters. This antenna exhibits good efficiency with small size at relatively low height above he ground.

A recent article describing the use of loop antennas in Viet Nam[1] led the authors to plan and build the Ferris Wheel antenna described below. The Ferris Wheel is compact, inconspicuous, inexpensive, portable (if desired), broadband, and reasonably efficient. Its radiation characteristics are quite good—in fact the Army Limited War Laboratory found that a vertical loop antenna surpassed a low dipole in terms of radiated power[2]. Since the lower bands, particularly the 2 MHz and 4 MHz bands, are transmitted with low-hanging amateur antennas, the Ferris Wheel seemed an ideal antenna for low-frequency work. The antenna is good for both short and long skip, since it has good radiation characteristics at both low and high angles. The Ferris Wheel is an ideal field-day antenna, since it requires virtually no support on a calm day, and only minimal

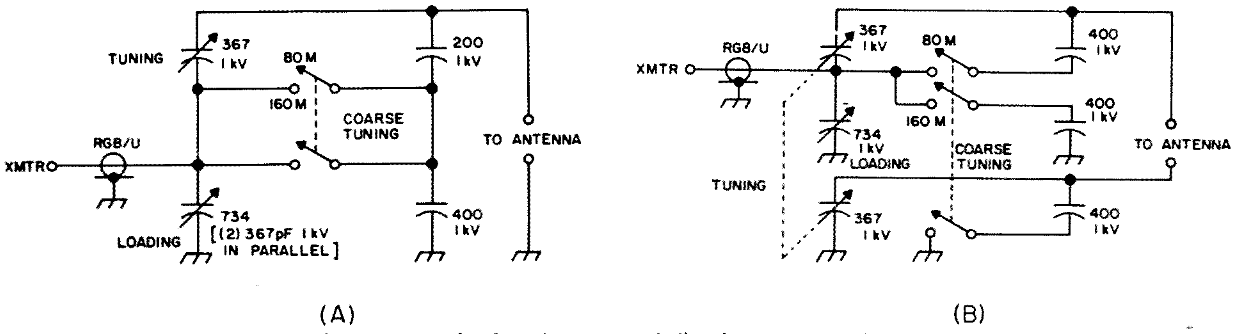

Fig. 2. Antenna tuning matching networks for the Ferris Wheel antenna. The circuit in A is for low-power applications; the circuit in B for high power.

support on a blustery day. Finally, as a permanent antenna, the Ferris Wheel is quite sturdy, the model built here having survived both small-craft and gale warnings with no ill effects.

The Ferris Wheel antenna (**Fig. 1**) is a loop antenna mounted vertically upon the ground. Since the radiation resistance of a loop antenna is very small (see **Table 1**), the conductor forming the loop must be made as large as possible in order to achieve reasonable (if disadvantageous) efficiency. In order to reduce loss resistance, we selected 2-inch aluminum downspout as the conductor of the Ferris Wheel. Obviously, we used unpainted, bare aluminum.

A forty-foot circumference loop antenna, made of 2-inch aluminum downspout, will have reasonable (17.5%) efficiency at 2 MHz and better (70.7%) efficiency at 4 MHz. Conveniently, aluminum downspout is sold in 10-foot sections. Since radiation resistance is proportional to the square of the area of the loop[3,4,5], an octagonal shape was chosen over a square shape since the octagonal has 20% more area for the same circumference, and thus, the radiation resistance is 44% greater. Additionally, five-foot lengths of downspout are much more convenient to handle than ten-foot lengths in a portable installation, and 45-degree elbows are readily available while 90-degree elbows are not. Both elbows are listed in catalogs, but the 90-degree elbows are generally missing from the local dealers' shelves.

The capacitive tuning network (**Fig. 2A**) is simple to make and to tune, and it will handle powers of several hundred watts. The values shown tune the antenna within the 160-meter and 80-meter amateur bands. For higher power operation, the balanced network of **Fig. 2B** may be used. Tuning this network is more difficult, but by no means impossible.

The Ferris Wheel antenna has given excellent results, both on 160-meters and on 80-meters. One evening, on the first try made on that band, we made a contact of 400 miles on 160-meters, and we had several contacts on 80-meters, ranging from 3 to 600 miles.

The key to success with the Ferris Wheel is to maintain low resistance in all joints and connections. To achieve this we force-fit each joint between the downspouts and elbows, and then drilled three holes, approximately 120-degrees apart, and then riveted each downspout-to-elbow joint (**Fig. 3**) with aluminum rivets. The rivets were inserted with a hand riveter, available for about $5.00 at either a harware store or Sears. Aluminum rivets must be used to avoid future electrolysis and corrosion at the joints. At the feed point, an inch-and-a-half was removed from the center of the five-foot downspout, and a paraffined wooden plug was inserted in the downspout as a spacer (**Fig. 3**). Connection was made to the feedpoint with

The Ferris Wheel antenna mounted to the side of WA7CUS's house.

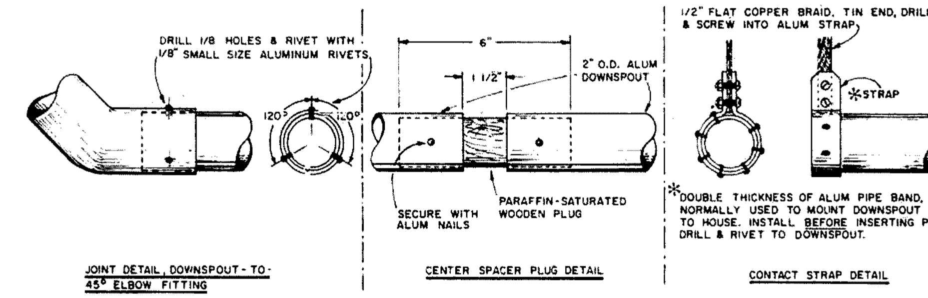

Fig. 3. Construction details of the Ferris Wheel antenna.

double aluminum strap (available to affix the downspout to a house) riveted to the downspout as shown in **Fig. 3.** Half-inch tinned copper braid was screwed to the tabs on the aluminum strap (**Fig. 3**) and used to tie the loop to the tuning network inside the shack. The joints were all sprayed with Krylon (after riveting and attaching the braid) for weather protection. The loop was fixed to the side of the house with five aluminum straps, each made of a pair of downspout straps, and the loop was spaced 1¾-inches from the house with square, painted, wooden spacers.

The total time of erection of the Ferris Wheel antenna is less than five hours, including the hacksawing, cutting, fitting, drilling and riveting. The above time includes searching for spacer wood in a basement junk heap, spacer carving with a dull knife, but not paraffin treating, spacer painting, and construction of the tuning network. The network had been built before the antenna was raised. Tuning network construction is straight-forward (although number 14 wire should be used to make all connections), and is left to the imagination of the reader.

The radiation pattern of the Ferris Wheel antenna is directional in a horizontal plane, and is vertically polarized. Both the horizontal pattern and the vertical pattern are shown in **Fig. 4.** The patterns shown are those of a vertical loop, resting upon a perfectly conducting earth. The patterns do not differ substantially from those of a small vertical loop in space, and thus imperfect ground has little effect on the loop, as long as the loop is close to the ground. Patterson's article points this out, and a few moments analyzing a loop antenna and its image due to a ground plane will substantiate the result. Tests made on the antenna at 3.96 MHz within the state of Washington confirm the theoretical pattern.

The Ferris Wheel is a broadband antenna. Using the network in **Fig. 2A,** we found that once the antenna is tuned midband on the 75-meter band, VSWR remains with 1.6:1 throughout the band. But the Ferris Wheel is easily tuned, and with the aid of a VSWR bridge, it can be adjusted rapidly. Patterson's article shows a VSWR bridge built into the tuning unit, and for installations where the antenna is not at arm's reach from the transmitter, a bridge built into the tuning unit would be most convenient. Since the feed point can be anywhere on the loop, the antenna feedpoint can be placed convenient to the transmitter. Initial tuning (within 2:1 VSWR) can be made by tuning the antenna to maximum signal output in the receiver (AVC off). Final tuning is done with transmitter RF power.

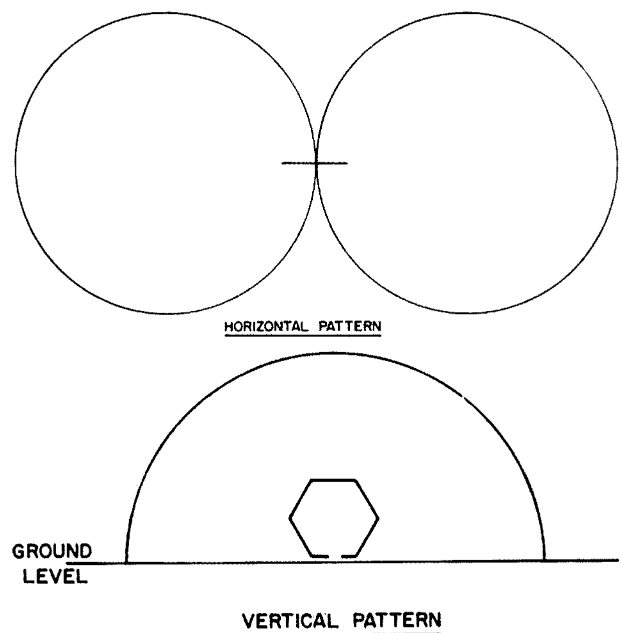

Fig. 4. Patterns for a small vertical loop antenna, resting on a perfectly conducting earth. Tests made by the authors appear to confirm that the Ferris Wheel antenna pattern closely resembles this theoretical pattern.

Since our initial tests on the Ferris Wheel antenna were made using force-fit joints between the downspouts and elbows, and during those tests we had good results from distant (12 miles) stations during the after-

Table 1. Comparison of antenna size, frequency and efficiency.

Frequency	Section Length	Radiation Resistance	Loss Resistance	Efficiency	Circumference
2 MHz	5 ft	$7.5\times10^{-3}\Omega$	$3.53\times10^{-2}\Omega$	17.5%	40 ft
4 MHz	5 ft	0.120Ω	$5.00\times10^{-2}\Omega$	70.7%	40 ft
4 MHz	3.28 ft	$2.30\times10^{-2}\Omega$	$3.28\times10^{-2}\Omega$	41.3%	26.24 ft
7.3 MHz	3.28 ft	0.259Ω	$8.85\times10^{-2}\Omega$	74.5%	26.24 ft

noon on 75-meters, we concluded that a force-fit Ferris Wheel would make a useful field day antenna for the two dc bands. Performance is not deteriorated by resting the loop on the ground, so long as losses are not increased at the feedpoint (from moist earth, for example). For the initial tests, our loop was rested upon a wooden 4x4 on the ground, and the loop leaned against the side of a house. In the field, the Ferris Wheel could rest on the ground, and lean against a tree for support. The five-foot lengths of downspout slip easily into the back seat of a car, or into the back of a station wagon, and the elbows are simple to store and carry.

Table 2. Material required for the Ferris Wheel antenna.

Part	Quantity
Downspout, 2-in diameter, Aluminum, 10-ft. section	4 each
Elbow, 45-deg., 2-in. diameter, Aluminum	8 each
Strap, downspout mounting, Aluminum	14 each
Rivet, 1/8-in., Aluminum, small	70 each
Nail, Aluminum, roofing	12 each
1¾ x 1¾ x 24-inch unfinished board	1 each
Plastic spray, krylon spraycan	1 each
Paint, house (to match QTH decor), to paint mounting spacer blocks	As needed
Capacitor, variable, transmitting,	1 each
1 kV, 365 pF	1 each
Capacitor, ganged variable, transmitting, 1 kV, 365 pF each section	1 each
Capacitor, silver mica, 1 kV, 400 pF	1 each
Capacitor, silver mica, 1 kV, 200 pF	1 each
Switch, ceramic wafer, 2PST	1 each
Braid, tinned copper, 1/2-inch	6 feet

The Ferris Wheel antenna can be made for higher frequencies than 2 MHz and 4 MHz. **Table 1** lists radiation resistance, section length, and efficiency for a 2/4 MHz antenna and for a 4/7.3 MHz antenna. At higher frequencies, the advantages of a small loop are far outweighed by the advantages of other types of antennas, and so the calculations are not presented for frequencies higher than 7.3 MHz.

The Ferris Wheel is an inexpensive, simple, and effective antenna at 2 MHz and 4 MHz. It is easily erected for either a permanent installation or for field day. It can be made of readily available materials **(Table 2)** within an afternoon.

. . . W7UGV, WA7CUS

Antenna efficiency is given by

$$\text{efficiency} = R_r/(R_r + R_l)$$

where

R_r = radiation resistance = $3.12\times10^{4}\times(A)^2/(\ \ )^4$ ohm

R_l = loss resistance = $6.25\times10^{-7}\times(s)(f)^{1/2}$

s = circumference in feet

f = frequency in Hz

The logic leading to the above formulas is found in reference 4, Chapter 12, Section 10; Chapter 5, Section 17.

References

[1] Patterson, Kenneth H., "Down-to-earth Army Antenna," *Electronics* (August 21, 1967), 111-114.

[2] *loc. cit.*, p. 114.

[3] *loc. cit.*, p. 113.

[4] Ramo, Simon, *et. al.*, *Fields and Waves in Communication Electronics*, pp. 288-303, 656-657, New York, John Wiley & Sons, Inc., 1965.

[5] King, Ronold W. P., *et. al.*, *Transmission Lines, Antennas and Wave Guides*, pp. 224-230, New York, Dover Publications, Inc., 1965.

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100 KHZ Thin-line Pulse Generator

Digital integrated circuits are an entirely new kind of electronic component. These finished, ready-to-go devices contain complex transistor circuits in tiny, convenient packages. Until recently they were too expensive for one-off projects, but a burgeoning market and competition between manufacturers have brought some prices to the dollar apiece level. In fact, very good digital IC's are now available on the surplus market.

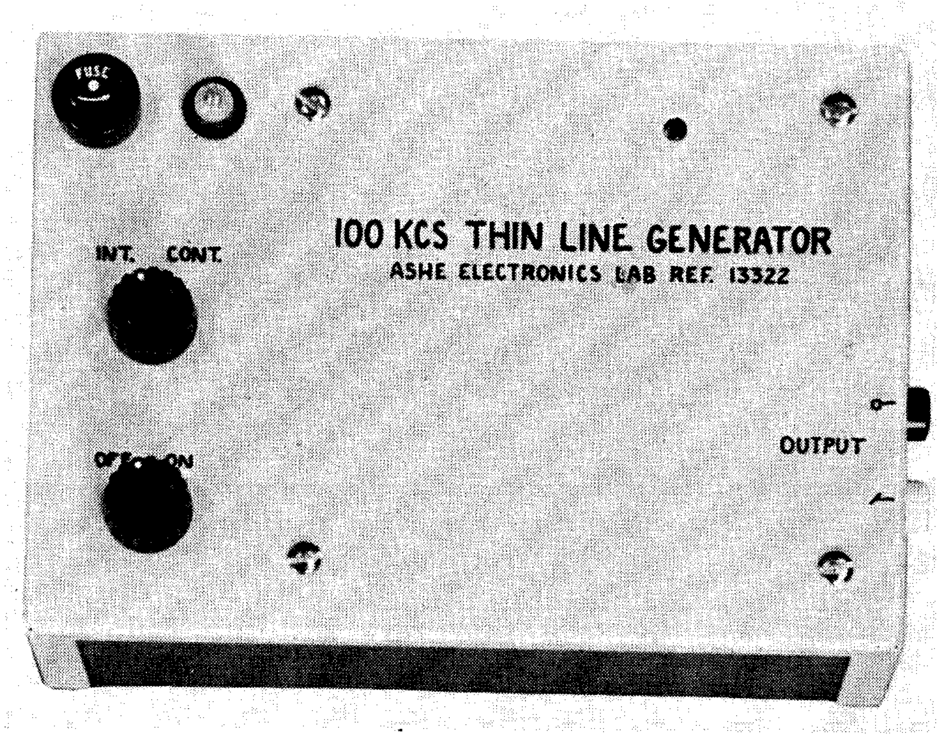
Perhaps because they are so new, it is hard to see applications for digital IC's outside the computer and industrial control scene. It takes a little while to adjust mental perspective, too, before their input-output characteristics begin to seem natural. Yet, there are applications for them which are not very difficult. For instance, how about a frequency standard?

Ordinary 100-kHz frequency standards are usually audible up to a few tens of megahertz. A good one might be usable at 50 MHz. The circuit described here uses a dual NAND gate to generate a 100 kHz signal whose harmonics are usable to 432 MHz or higher. And it can be built without benefit of special instruments and knowledge.

The thin line pulse

One rather surprising result of higher mathematics is that all repetitive signals are composed of harmonically related sine and cosine waves. For example, the familiar square wave is composed of a fundamental frequency, which sets its basic repetition rate, and of odd harmonics only of its fundamental, which contribute to its square corners. If the harmonics' amplitude or phase relationship is upset, the square wave is distorted. This feature makes the square wave very useful for amplifier testing, but its harmonic content is not very good for frequency standard applications.

Now suppose that we start adding up signals of F, 2F, 3F, and so on, phased in so that they all reinforce each other once per cycle. Let's say thay are all the same amplitude. What would we get? See **Fig. 1A.**



External view of the 100 Hz thin-line generator.

The five equal amplitude sine waves peak simultaneously at the beginning of the fundamental's cycle. Everywhere else, until near the end of the cycle, they are more or less out of phase. Trying to see what will happen, we try adding the first two frequencies. **Fig. 1B,** the result, might suggest something to a mathematician.

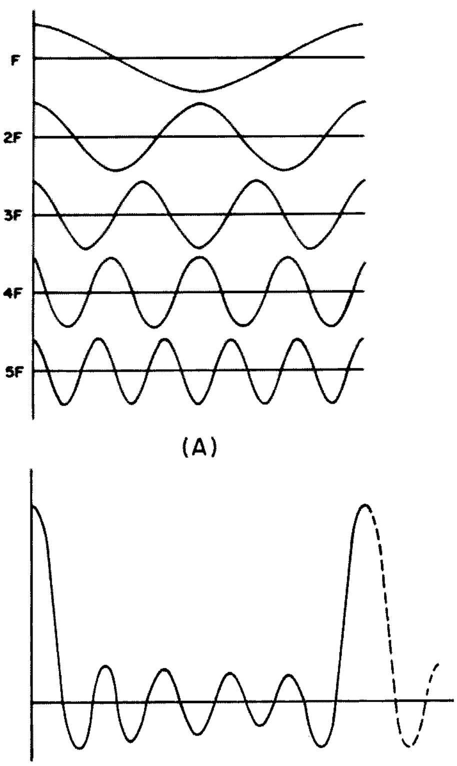


Fig. 1. Five sine waves (A) and the waveform as a result of point-by-point addition (B).

As the number of frequencies is increased, their amplitudes tend to average to zero everywhere except at the beginning of the cycle. Here, they all add up to a short, sharp pulse. It follows that a short, repetitive, one-sided pulse should contain odd and even multiples of the fundamental frequency.

An ideal thin line pulse has infinite frequency content.* No real signal could meet this spec, but a fast digital IC can produce a very workable approximation. **Fig. 2** shows a Tektronix 545A view of the generator output and tests with other scopes indicate the real pulse has better rise time and sharper corners than shown here.

If this pulse is viewed on a low-performance service variety scope, its appearance will be greatly changed. There will be an apparent loss in amplitude, since the pulse occurs and terminates before the slow circuitry can properly respond. The apparent duration is increased, also because of the slower viewing circuitry. And the fast pulse may excite circuit resonances, so that the thin line pulse appears as a damped oscillation. But these problems do not interfere with constructing the generator, because the very simple NAND gate circuitry contains no critical elements or adjustments.

How it works

There are four circuit sections, shown in **Fig. 3.** A 100-kHz crystal-stabilized oscillator sets the basic frequency, and a dual NAND gate circuit converts the oscillator output to a thin line pulse. A 1-Hz astable generates the output marking signal. A 6 volt dc power source is provided by a voltage doubler zener-regulated supply.

Multivibrator oscillators are not ordinarily very stable frequency sources. But if the oscillator is designed to run slightly below required frequency, and an appropriate crystal is connected between transistor base terminals, oscillations are stabilized at the crystal frequency.

The crystal does not change the multivibrator's style of operation. It synchronizes the astable to its own frequency, by triggering the OFF transistor into conduction shortly before normal RC turn-on. The output is a squarish wave with good fall time, but a long rise time as shown in **Fig. 4A.**

In passing through the first NAND gate the pulse is squared up and becomes slightly unsymmetrical. See **Fig. 4B.** A differentiating network, C7 and R11, converts the square wave into the pulses shown in **Fig. 4C.** These pulses, applied to the second NAND gate, reappear as the thin line pulses shown in **Fig. 4D.**

Since one CW signal sounds just like another and there may be several in the vicinity of a check point, a marker feature is required. This is provided by the 1-Hz astable, which paralyzes the second NAND gate part of the time. Its base bias resistors are unequal, giving a distinctive duty cycle to the output signal. A switch disables the astable if a continuous signal is required. **Fig. 5** shows the output when the second astable is operating: the output is locked in the up condition during half of each 1-Hz astable cycle.

Sometimes an astable oscillator will refuse to start oscillating when it is turned on. It does not start because both transistors are

*Smith, *Applied Mathematics for Radio and Communications Engineers*, Dover Publications, 1961.

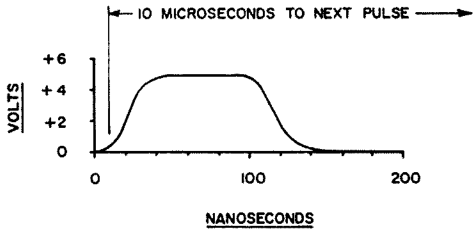


Fig. 2. Real circuit output as seen by a Tektronix 545A oscilloscope. A faster scope shows shorter rise-time and sharper corners.

in saturation. This reduces loop gain so that available noise cannot be amplified around the loop. It would never start without some strong, outside interference.

A pair of diodes, D1 and D2, provide a reliable remedy. The diodes are arranged so that base bias must come from whichever collector is at the higher voltage. If both transistors are in saturation, their collectors are at perhaps 1 volt, which cannot provide enough base current to keep the transistors in saturation. This contradictory situation does not arise in the real circuit, which starts reliably.

Additional diodes, D5 through D8, appear in the base circuit of the 1-Hz astable. These are protective diodes. The collector swing at turnoff of about 5 volts is conveyed powerfully to the opposite base through the large coupling capacitors C5 and C6. The reverse B-E breakdown voltage of these transistors is not known, so the diodes are provided to prevent the turnoff voltage exceeding 2 volts or so.

DC power for the Generator circuitry comes from a voltage doubler supply based on a low-current filament transformer. Its design is conventional, but a large capacitor, C12, is provided across its output to minimize noise on the supply line. The supply could be replaced with some batteries, shunted by a 50 μF or larger capacitor to absorb transients. The original breadboard ran very well, powered by four flashlight batteries.

Construction

The generator is built in a Premier #PMC

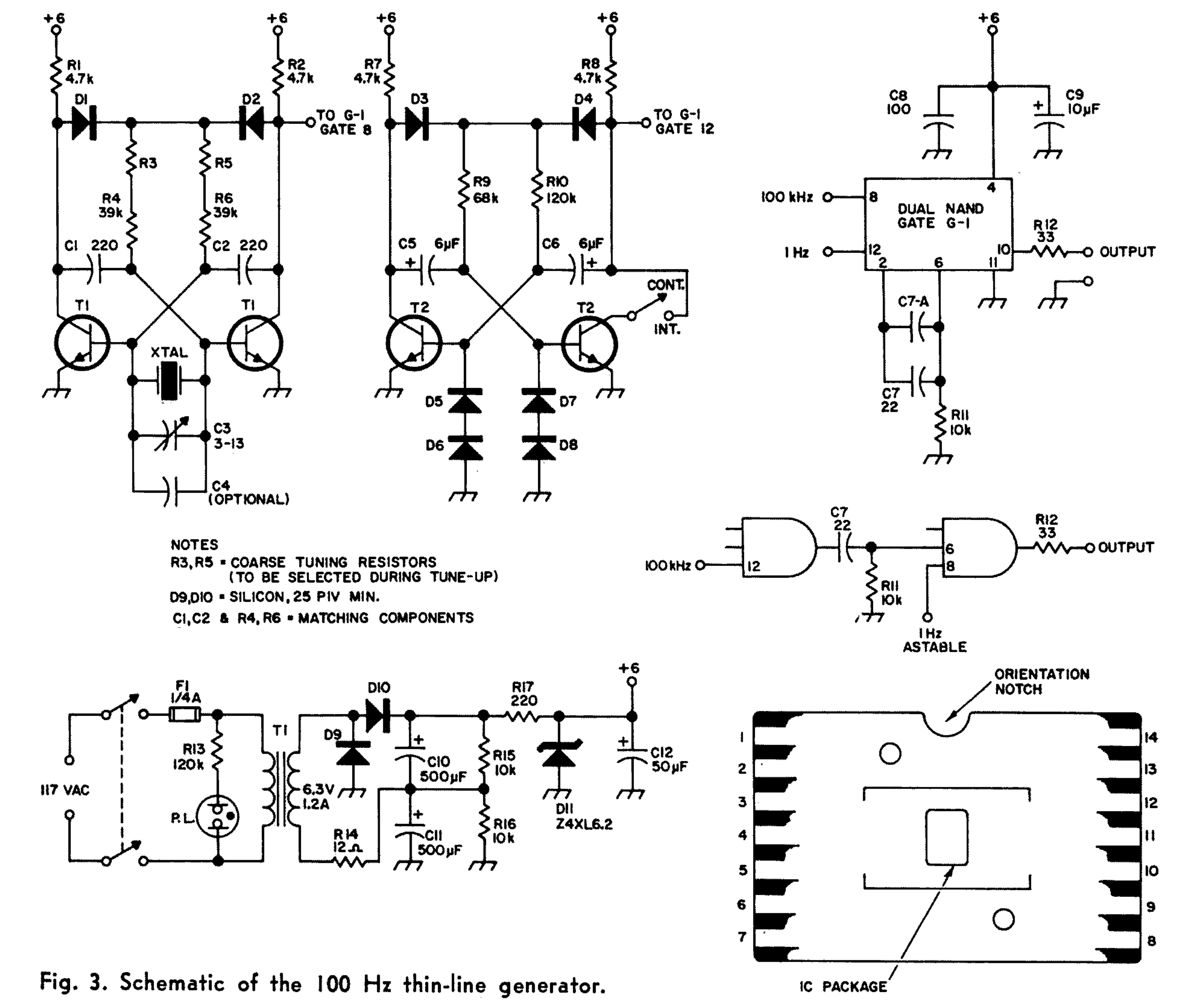


Fig. 3. Schematic of the 100 Hz thin-line generator.

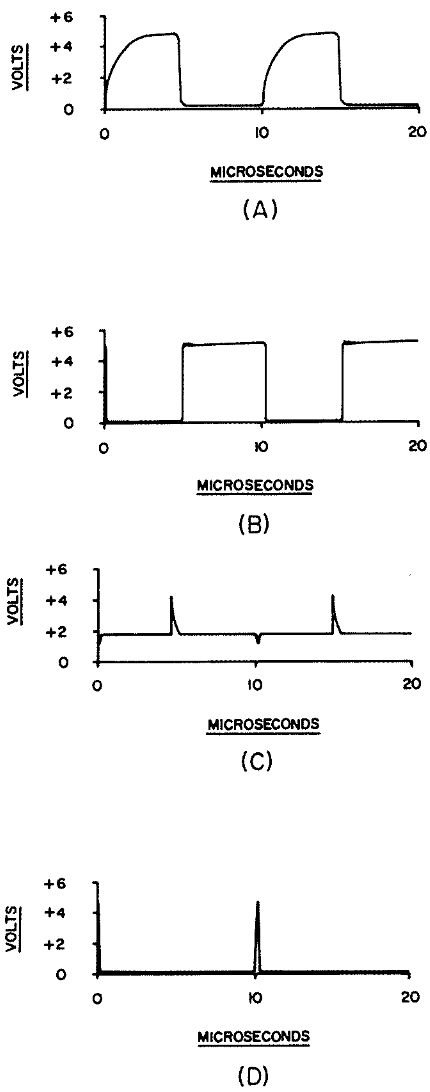


Fig. 4. Signals at four critical points in the generator, as displayed on a Tektronix 545A oscilloscope. They are shown in time coincidence.

1008 3x5x7 inch heavy aluminum box. Its top cover was refinished in light green enamel, and four ⅜ inch grommets in the bottom piece serve as protective feet.

Inside the box, the 6.3-volt transformer and cheater cord connector are mounted on the left-hand wall. A pilot lamp, fuse, and two switches are mounted on the horizontal panel, at the extreme left. This leaves just enough open space for the two circuit boards which occupy most of the box. Two banana jack output connectors are placed on the right-hand side, just below the panel.

The circuit boards are cut to 4½ x 5 inches, from Vector 3/32 inch pattern A stock and mounted parallel to the panel. The upper board is spaced an inch from the panel, and carries both astable oscillator circuits. The other board is mounted one half inch below, and carries the digital IC and the power supply circuitry. Assembled, the two boards make a sandwich with wiring sides together.

Both boards are mounted on the same four centers. These are through the second hole diagonally inward from each corner. The 1 inch 6-32 internally threaded spacers are modified by adding a short length of 6-32 threaded shaft to one end of each, simplifying assembly.

Component assembly on the boards is largely a matter of plugging in Vector T9.4 lugs. The finished product looks much better if some thought is given to facing the lugs in one of two directions. Mounting and transistor holes should be drilled and reamed to size before installing lugs.

The general arrangement puts all wiring on one side of the board and practically all components on the other side. This approach seems a little inflexible but is straightforward and looks good.

Possible board orientation problems may be overcome by working out a handling and wiring procedure that doesn't require constant reference to actual components. A good approach assumes that the board is only turned over an imaginary hinge at its bottom edge, so that top down when one side is up becomes bottom up when the other side is down. This preserves left-right relationships. Another useful convention is that all supply wiring goes to left-hand end of components.

Wiring is carried out one network (plus supply lines; ground lines; interstage lines, etc.) at a time, with prearranged color coding. Bare wire goes for short runs and where there is no chance of a short. Solder each lug when convenient. #22 solid wire fits the T9.4 lugs well, but flexible stranded wire is used for the four lines from one board to the other.

Transistors precede other components into the board, because they are convenient position markers. They are placed in their

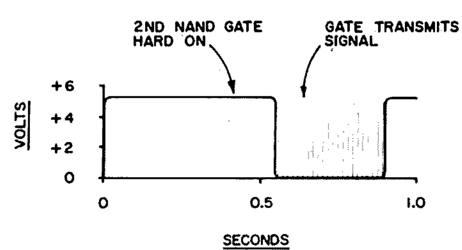
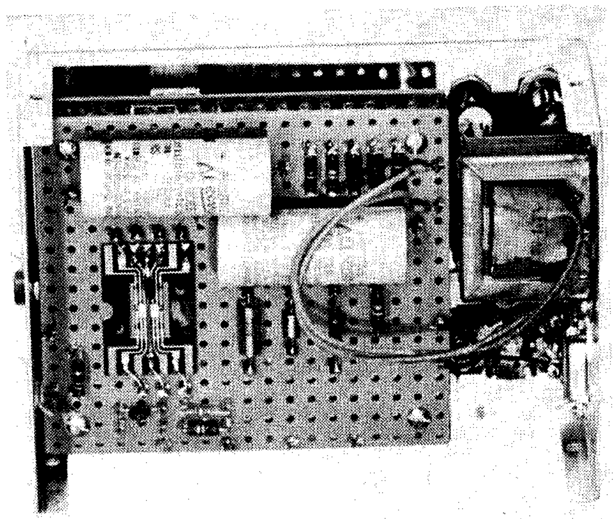


Fig. 5. The second NAND gate locks in its up position part of the time to produce an intermittent output.



Inside the assembled thin-line generator showing the component side of the power supply and IC board.

mounting holes in the board from the component side, and their leads brought to the T9.4 lugs.

Then the other components are mounted on the boards.
product. Diode and electrolytic capacitor mounting polarity should be double checked. The T9.4 lugs may need a little bending before they will take a good grip on the components, but no component soldering is done until everything is installed.

Trimmer capacitor C3 is mounted on its tabs just under the top panel. Then a small screwdriver access hole is drilled over it in the panel, before painting, for vernier frequency adjustment after final assembly.

Certain components are matched before installation. An ohmmeter and a capacitor checker will do a satisfactory job of selecting C1 and C2, and R4 and R6, for equal values. These components are chosen alike for best symmetry of the 100-kHz oscillator operation. It might be good planning to leave these components unsoldered until tuning is completed, but everything else can be soldered to the board at this point. Note that the R3 and R5 sites do not get resistors until later.

Two optional capacitor sites are included. These are for C4, an additional and probably unnecessary padder across the crystal; and C7A, which can be added to increase the width of the thin line pulse.

Apparently, the digital IC comes in a specially designed package for testing before use. To mount the IC, solder a ⅜ inch piece of #22 wire in each of the T9.4 lugs carrying supply and signal voltages to the IC. Place the IC between the two rows of lugs, bend the wires against the proper terminals, and solder. No other mounting is required.

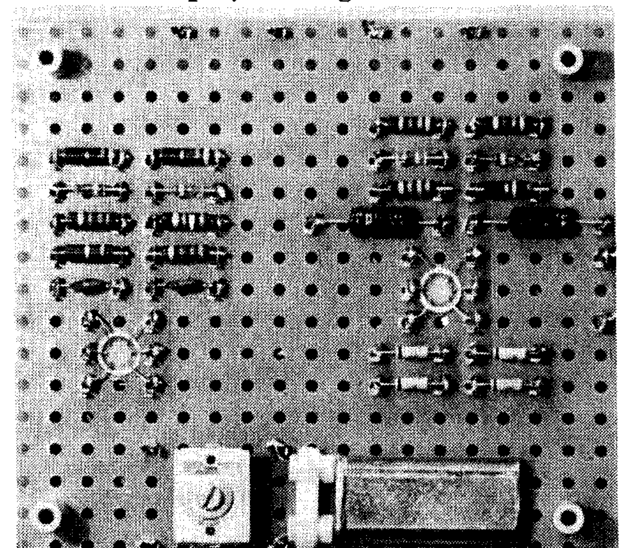
The original breadboard showed a lot of transient noise in its supply circuit. This originated from the IC, which was trying to get big chunks of current to manufacture pulses. Since the IC cannot deliver frequencies not available from the supply lines, very careful bypassing is indicated.

High-frequency bypassing consists of C9, a .01μF disc ceramic capacitor across the IC supply terminals on the wiring side of the board, and C10, a 100 picofarad capacitor soldered directly between supply terminals on the IC. The capacitor leads are provided with spaghetti insulation and placed for minimum open space between the capacitor leads and the IC's supply leads.

Testing before final assembly is very easy, because the odd appearing board layouts go together giving a structure that opens out like a book. The hinge is the four leads between boards. Leave transformer leads long, so that the circuit may be tested well free of its cabinet.

The upper half of the Premier box is prepared by a powerful cleaner which removes its original paint. After thorough removal of the cleaner, the metal is roughened with wet sandpaper, rinsed in vinegar solution and then clear water, leaving a very good surface that does not require priming for excellent paint adhesion. Watch out for greasy fingerprints.

Rustoleum #868 Green applied from a convenient spray can gives a fine finish.



View of the component side of the astable oscillators board.

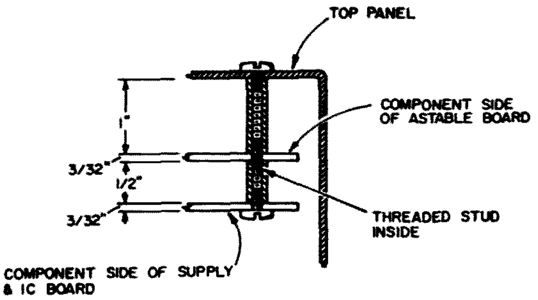


Fig. 6. Mounting dimensions and spacer assembly diagram.

Follow instructions on the can. After drying, the fresh, clean enamel will take waterproof India ink, applied with a Leroy drafting pen. When the ink is thoroughly dry, a final coat of Rustoleum #717 Clear finishes the job. The enamel is soft at first, but hardens into a coat durable in normal lab use.

Table of special parts

Crystal: 100 kHz parallel resonant 32 pF. shunt capacitance normally designed quartz crystal.

The following parts were obtained from Solid State Sales, P. O. Box 74, Somerville, Mass. 02143.

- T1 & T2: 2N2060 type dual NPN transistor
- D1, D2, D3, D4: fast point-contact Germanium diodes coded 1N59
- D5, D6, D7, D8: fast point-contact Silicon diodes marked S284GM
- G1: surplus digital integrated circuit Solid State Sales type G1. (comes with data sheet)

Tuning up

The generator should be zeroed to frequency before installation in its case. This is a two-step process. First, the 100-kHz astable base resistances are adjusted by choosing resistors for R3 and R5 to bring the oscillator frequency within trimmer range of 100 kHz, perhaps a few hundred cycles high at 15 MHz. Then the trimming capacitor brings the frequency to accurate coincidence with WWV.

To roughly zero the generator, set the trimmer capacitor, C3, at minimum capacitance. Identify WWV on a short-wave receiver, and tune around a bit to familiarize yourself with what's happening in the vicinity. It would be nice if things are fairly quiet.

Then put 4.7k resistors into the astable board at the R3 and R5 sites, turn on the generator, and look around for the signal. Depending upon actual values of CI and C2, the signal may be on either side of WWV but is likely to be on the high side. If so, try again with resistors one size larger, which will lower the frequency. You should shortly find resistors that bring the frequency near enough to WWV for final zeroing with the capacitor. Verify tuning range on both sides of WWV.

Correct values for R3 and R5 may be approximated very quickly if a good triggered scope is available. Try selecting resistors for a period of 11.4 microseconds with the crystal removed.

Using the thin line generator

A breadboard test showed that (as might have been expected) there should be some way to distinguish generator signals from other CW signals. The continuous/intermittent feature provides the marking, and once the correct signal is located the generator can be switched to "continuous" for accurate work.

At low frequencies, the generator output and behavior resembles a conventional 100-kHz standard. The signal simply is not as strong. A greater difference appears at higher frequencies: the original model yields an audible beat note at 80-MHz from a diode mixer through an inexpensive audio amplifier. And another test shows a usable signal at 432 MHz: the 4,320th harmonic.

Some connection to the receiver or other detector is required. This is a natural consequence of a circuit design that puts the signal where it belongs, rather than spraying it all over the lab. A few picofarads coupling capacitance is sufficient at all frequencies.

Perhaps this circuit can be used for purposes other than a frequency standard. Its moderate amplitude but wideband output should be ideal for detecting changes in receiver sensitivity over a broad tuning range. In fact, with a little decoupling of the input leads and provision of a coax output connector the generator should do well as a stable, reliable small-signal source. A piece of adjustable waveguide-below-cutoff would make an excellent attenuator for work not requiring exact measurements. Another thought that occurs is possible further development by provision of some arrangement for detecting which harmonic is actually being heard.

. . . W2DXH

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The Nurture and Care of a Junk Box

The idea of "the junk box" has been laughed at, slandered and otherwise maligned during the past couple of years. This fun-making and detraction has gone on both in the magazines and in QSOs. Maybe it is time to take a second, and a close, look at this institution which is as much a part of ham radio as are DX contests and YL chasing.

Why has there been so much disparagement? My own idea is that writers for ham publications have assumed (usually erroneously) that readers had junk boxes as extensive as, and identical to, their own. When readers figured out the cost of what they had to buy to complete the particular project under consideration, they often gave up rather than strain their budget. However, if those readers had been making a systematic effort to grow themselves a good supply of used parts, they might have built the gismo for less than it cost the author.

Extensive parts collections don't just happen. They are grown more or less intentionally. Here are a few hints on the accumulation of parts and how to handle them after you get them. My XYL says this is the only subject on which I am an expert, so maybe others will find the techniques useful.

1. Let it be known among yout friends and acquaintances that you are interested in electronics. Forthright announcement is sometimes appropriate, but demonstrations are better for they make a more permanent impression. Display of some electronic gadget or your call letters can be used to advantage. Gadgets give you the best openings for conversation on the subject. "Commercial killer" for a TV set or a neon bulb flasher are examples. When it is learned that "he built it himself", not a few friends and relatives will say, "Maybe he can fix that old radio in our attic, and if not, maybe he can use the parts." Needless to say, the radio is beyond repair 99% of the time. When you are offered pay for a small favor ask if there is an old radio or record player you might have. Sometimes these are repairable and can be used for swapping material.

2. The offer of old electronic gear brings us to the second point: Never refuse an offer of anything. Don't refuse even if you are certain beyond any doubt that you can't even get the beast into your basement or

use any part of it. The friend making the offer sees himself as doing you a favor by offering it and at the same time is getting his attic cleaned. And who knows, you might find just what you need in it for a project 5 years later. Such an unlikely prospect as a broken egg beater has been turned into strap to hold a tubular electrolytic in place, and the wood from the handle used for insulating spacers!

3. Approach likely sources of used equipment which can be stripped. Repair shops for TV and radio, 2 way radio, and salvage businesses are good prospects. One fellow got the privilege of hauling away the trash from a TV service shop. No one specified that it was all to go to the dump, and you can bet it didn't. He netted a couple of chasis per month in return for an hour's work, and supplied the local demand for power transformers. He could have developed a tremendous stock of resistors if he had wanted to.

4. If absolutely necessary, buy equipment that has many usable parts. The best example of this is the plug-in units from computers that several of the well known mail order houses currently list in their regular catalogs. These have many parts useful in general construction projects such as standard value resistors, terminal strips, etc. One was recently obtained which had an even one hundred diodes plus almost as many resistors for a single dollar bill. Some military surplus is worth purchasing if the price is very low. Auto junk yards will often sell non-operating radios for a buck or so. The transistors or tubes can be worth much more than that, and if the speaker is thrown in, that makes a real bargain. Some of the best hunting can be done at auctions, both radio club and commercial. Unlike taking gifts mentioned above, be discriminating in what you buy. It is not a bargain if you have no use for the parts.

5. Carefully choose assortments to fill in the gaps in your parts supply while you continue growing your own collection. These can often be bought at half what they would cost if purchased individually. The more precisely you know what is in the assortment the more it will cost however. Experience shows that grab bags of a specific part such as capacitors or knobs from well known mail order houses are well worth the money. This is not always true of assortments from smaller places. For example, a pound of resistors from a relatively obscure supplier contained a half pound of 22,000 ohm 2 watters. That value is great, but who needs 75 of them?

6. Avoid the "5 pound surprise box". The surprise is seldom a pleasant one. These are usually made up from odds and ends which can not be sold otherwise. Even so, some guys will gamble. One such assortment contained 2 pounds of packing!

7. Develop a working swap arrangement with other fellows in your area who have a junk box. This can effectively multiply the stock of parts you have to choose from. Be sure to test the parts before the deal is final. This can save a mutually beneficial friendship.

A place you are likely to find people interested in swapping is the local ham club. Fellows who attend are the ones most likely to be active in building. Putting out feelers on local VHF nets is another way to establish contact between builders. A somewhat unexpected source of possible fellow hobbiests is the names found on the book cards of people who have recently checked out electronic books from the library.

Now that you have accumulated the equipment with all those useful components in it, let's don't chuck it under the workbench for future reference. Trying to locate a specific relay or capacitor to fit the specs of that article in the latest issue of 73 can be time consuming as well as frustrating. Two words that are a must in the nurture of a junk box are *organize* and *test*.

To organize those goodies, you have to get them off the original chasis. Hand tools, a soldering gun and soldering aid are essential. Unsolder parts whenever possible rather than clipping leads. This is more time consuming, but will save later frustration when looking for a component with leads long enough to reach without having to splice. Often as much as ¾ inch of wire is wrapped around the terminals. Such items as sockets, relays, and terminal strips, are then ready to use without requiring cleaning. When there is a long evening while wating for that next magazine, get out the tools and start stripping.

No sensible person is going to dump all those parts into one big box. Everything from shoe boxes to olive jars has been suggested for separating and storing the parts.

The type container is not as important as having some kind of system. If you can pry loose some savings stamps from the XYL's horde, you might get some of the plastic drawer cabinets which are ideal for smaller components.

Don't stop by just putting the parts into the boxes or you will end up looking thru nineteen shoe boxes to find which one the tube sockets are in. A child's wax crayon or a china marking pencil is a cheap, quick, and easy labeling instrument.

Then we come to the testing. Who wants a basement full of parts that he is not sure are usable? Most experimenters have an ohm meter that will take care of the resistors and inductors. Radio clubs often have test equipment they will loan or rent to members. Many amateurs will test components gratis for a fellow hobbyist if they have the equipment to do so, or have access to it. Drugstore tube testers tend to develop bad socket connections. Since they are not checked very often, they may indicate a fault where there is none. If you must use them, be very cautious in disposing of "bad" tubes. The bases from octal tubes make excellent cable terminals and don't require expensive sockets either.

This isn't the place to get into testing procedures for they are well covered in other articles. It might be a good investment of your time and horde of parts to use some of them in building test instruments for finding the condition of parts you may acquire in the future.

A word of caution is in order. Do not be in too big a hurry to wreck out everything you get your hands on. Such things as audio amplifiers can be used around the shack for a variety of purposes like conversion to an intercom or a modulator. Radios, especially transistor radios, as well as record players and intercoms can be profitably bartered or sold.

Now you can compete with the best of the scavengers. So start saving your pennies. No, not for snapping up the bargains. You're going to need a bigger shack to store all those junk boxes!

. . . WØHMK

A word to radio clubs

Fellows, is your club doing the best job it can to encourage new amateurs in your community? Rate your club . . . . .

1. Does your club have an organized program to invite CB'ers to come to club meetings and get acquainted?
2. Does your club roll out the red carpet for newcomers? Are they introduced around? Do you have a committee whose responsibility it is to see that these fellows are made welcome and who answer their questions for them?
3. Do you have a short technical session before or as part of each club meeting? Is this session run by someone who is a good teacher and knows his stuff?
4. Do you have a code practice class run by your club?
5. Does everyone in your club feel wanted and welcome or is there a small clique trying to keep out the Novices and unlicensed fellows?
6. Do long business meetings make your club dull for newcomers?
7. Do you have a refreshment session at the end of a meeting to allow everyone a chance to chew the rag?
8. Do members with technical questions and problems have anyone they can call or turn to for help?
9. Does your club help members to put up beams, towers, and other operations where a group is needed?
10. Does your club have a local VHF channel where members can call in for assistance or information?

Count ten points for each unequivical yes, less for yes, buts.

The newcomer to amateur radio has a hard row to hoe and it is up to the rest of us to make this path as simple to follow as possible. The Novice license is easy to get, but right at this point the Novice needs help badly if he is not going to waste a lot of money buying equipment which is going to frustrate him. The Novice bands are crowded and are no place for junky gear. You need good receivers and rigs to get any enjoyment out of these busy bands. A poor receiver will end one contact after another due to QRM. This can completely discourage just about anyone. It is no wonder we lose so many Novices each year. The wonder is that as many get through this baptism of QRM as do.

. . . W2NSD/1

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How to Plan Your Own DXpedition

A DXpedition to the Cayman Islands by K4CAH, W4KET, W4PJG, and WA4WIP

First look for some rare or semi-rare country with an exotic call that is easliy accessible. We looked in the Caribbean area. Navassa was out of the picture, the VP2's were available, but had really been worked over during the past year. We tried to obtain a VP7 license but were unsuccessful. So Grand Cayman Island was what we were looking for. A new exotic prefix of ZF1 was recently assigned, having been changed from VP5. This, in fact, caused us some trouble. Many stations not finding ZF listed in their "late" 1950 call book, openly accused us on the air of being pirates.

Nice hotels on beautiful beaches were available, that would cooperate with a bunch of hams and their strange array of equipment. And most of all, after completing an application form along with $14 U.S. funds, two months of waiting, and some help by the country's only active permanent amateur, Frank Scotland, ZF1GC, the call of ZF1EP was issued.

So! We had our country and our license. Let's throw our toothbrush in our pocket (Ernie, K4CAH being a dentist insisted on this) and put our sunglasses on for the Caribbean sun (Lou, W4PJG, an optometrist, demanded this) and be off—we thought. We soon found that there was just a little more to planning the trip. Questions, such as the following had to be answered: what equipment to take, linears or not, what type of antennas, what to support the antennas, was there commercial power available, how many stations to operate, how long a power cable to take, how much coax, ground rods, spare tubes and parts, test meters, does the plane fly into the island on the day we must go, do we need passports, innoculations, etc. etc.

ZF1EP DXpedition. QSL card. The shack in the background shows the hardships the boys had to put up with.

It was immediately seen that it would take several weeks to answer all of these questions. But we were determined to plan every detail in advance, even to assembling all gear and timing how long it would take to set up two stations with the color coded antennas, and be on the air. This advance assembly and trial paid off in an operation with no problems at all—a rare experience.

So we now have the country and the license along with some basic travel information, we knew we could get there.

In our case, Grand Cayman, British West Indies, is located 150 miles south of Cuba, 180 miles northwest of Jamaica, and about 600 miles from our home in Florida. It is easily reached by direct flights from Miami three days a week by LACSA Airlines. LACSA is a Costa Rican airline that serves that part of the Caribbean. The food and drinks served on this airline is superior to any we have ever experienced.

A U. S. passport is a must for any serious U.S. DXpeditioner. A passport is obtained by taking your birth certificate and two recent "passport size" photographs to your county clerk's office along with $9.00. It usually takes two weeks for it to be mailed to you. A recent small-pox vaccination form, verified by U. S. Health Dept., is also required to re-

Our shopping bags each contained a TR-4 or power supply. All other gear and antenna in the long package.

enter the U. S. after visiting the Cayman Islands and many other areas. It is of course wise to keep-up other appropriate innoculations such as tetanus, typhoid, etc.

We found by inquiring through the tourist bureau of Grand Cayman that several excellent small hotels were available on the island. The next step was to contact a hotel there and explain what we wanted to do as to erecting antennas etc., and make the reservations. Our choice was the Beach Club Colony Hotel which proved to be in excellent choice in accommodations, cooperation and fine meals. We then made our airline reservations. We were told that 24 hour commercial power was available on the Beach Club Hotel part of the island. This was a relief to find that we did not have to take, or to arrange for, generating equipment and gas. It remained to be seen however, that the voltage never did exceed 100 volts and most of the time was around 95. An autotransformer would have helped. Next on our list was the equipment and antennas. Since commercial power was available, we would only be limited in equipment by the amount of excess baggage charges we wished to pay on the airline. We were allowed 60 pounds apiece or with four of us going, a total of 240 pounds of baggage. If we exceeded this the cost would be 25 cents per pound.

Negotiations were made with the R. L. Drake Company to supply us with two complete stations consisting of the DRAKE TR-4 Transceiver and the RV-4 Remote VFO with the power supplies. This is truly the ideal DX rig. The remote VFO enables one to work different frequencies, with the choice of transmit or receive on either frequency at the flip of a switch. The TR-4 runs 300 watts PEP which we felt was ample power without paying the excess baggage cost which would be necessary if we took linears for higher power. More on this power factor later.

Probably the biggest decision to make was on the type of antennas to take with us. Again we wished to keep the weight down and this time also the size of the packages. We, of course, wanted the most gain possible for the least size. The discussion of which was best as far as weight, size, and efficiency was whether it would be better to take low power with a high gain antenna or high power with a low gain antenna, assuming that we did not want to take both the linear and the beam antenna. The decision as to taking the beam really also depends on what is going to be taken to support the beam. Then the question of a rotator came into the picture. Gus, Don, and others have shown that the easiest antenna to carry is the HY-GAIN Vertical variety. As we planned to operate all bands 80 thru 10 the HI-GAIN 18AVQ vertical was at once chosen for one antenna as it covers all these bands. The HY-GAIN TH-3 MK11 three element 10, 15, 20 meter beam was at last chosen for the other antenna. It was at first thought that the regular TV type three section 30 foot pushup masts with guys would be taken to support the beam, but it was later decided to take the type mast with 6 pieces of 5 foot interlocking steel tubing. The cost, unassembled length, and weight being less on the latter. The mast is a dispensable item for the return trip to save weight, if you like. Ample wire was also taken to make up coax fed dipoles if the need arose, and it did, due to the need to operate one rig on the 18AVQ on 40, and a dipole for the other rig on 80. Three lengths of coax were taken for each antenna, along with the necessary insulators and guy wire.

With all equipment on hand both stations were set up at the home QTH of Ernie, K4CAH. The antennas were carefully measured and assembled. As each section was tightened, the joint was sprayed with a can of spray paint so it would not be necessary to ever measure again on reassemble, just line up the paint lines. The sections of the vertical were numbered with a marking pen starting with number one at the base. In the case of the beam, each element was sprayed a different color on the joints for easy recognition of elements. A word to the wise here—DO NOT tighten down on the compression clamps too much if you ever expect to take

A Beam is a lot more trouble to erect and keep up, but the extra gain may be worth the effort.

apart and reassemble the antennas again with ease. Just tighten enough to hold. Once the HY-GAIN 18AVQ vertical has been preassembled in this manner, it can be unpacked and on the air in ten minutes. Other miscellaneous equipment included two microphones for VOX or push to talk, keys, W4KET took his TO-Keyer, spare tubes, diodes for the power supplies, fuses (which we almost forgot), small multi-test meter, headphones, ground rods, ground wire, ac extension cords, heavy hammer to drive ground rods, and other items for personal comfort such as insect repellent and sun tan lotions.

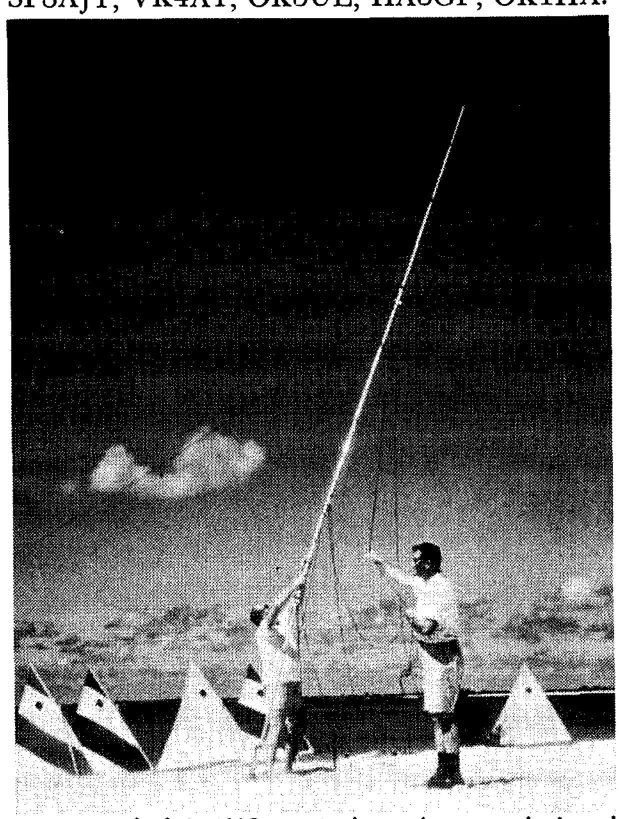
It is interesting to note that tne above equipment weighed 120 pounds and the package of antennas, ground rods, mast and coax weighed 117 pounds. It is also interesting to remember that airlines very carefully weigh all baggage and charge accordingly for any excess weight, but many times they do not take the time to weigh the contents of shopping bags or hand-held articles if these are not spotted by them until you are going through the gate to board the plane. Needless to say, the four of us were carrying "small" shopping bags with a Drake TR-4, RV-4, or power supply in each as we boarded the plane. As our checked baggage was "light" we paid no extra charges.

The flight from Miami was a pleasant one passing directly over Havana and the Bay of Pigs, Cuba. We were content to just observe the country side rather than attempt a DXpedition to that country.

We were met at the Grand Cayman Airport by Frank Scotland, ZF1GC, who stood by patiently as we made sure that our antennas were unloaded from the plane and as we passed through customs with no problems. We later visited Frank's shack where he owns and operates the power plant for the other end of the island from where we were staying. Frank may be found every night on 3915 SSB, and occasionally on 15 and 20 where he gives many their first ZF. Frank gave a helping hand many times during our stay. He was typical of the people on the island—the most friendly people in the world. The language is entirely English but with a slightly different accent from our own.

Our vertical was set up outside our cottage on the white sand of the beach only a short distance from the beautiful green-blue Caribbean water. Dick, WA4WIP, insisted on keeping the ground system around the base of the 18AVQ vertical well watered down with the salt water for a good ground. Apparently it paid off too. Our first contact from ZF1EP was on 15 meters to W8GCE followed by K7AQB, K8VCT, W8HIZ, K9URA, W5HWB all with 59 reports. On 20 meters the first QSO was with W4NPT, followed by W1BA, G3LGW, WA3EEK/3, W4NJF, WA1FOJ, all 59 reports. So we were "getting out".

Some interesting DX worked the first day on CW was YU1EXY, UB5KAA, LZ1KPG, SP8AJT, VK4AY, OK3UL, HA3GF, OK1HA.



A pre-marked 18AVQ vertical can be unpacked and on the air in ten minutes.

We were pleasantly surprised at the continuous "pile-up" on us during our 4 day stay on the island. We worked 5000 stations during our stay and we were well initiated into rapid operating techniques. During some one-hour operating stretches, over 165 QSO's were made, at times, one contact every 17 seconds. Ten meter pile-ups were the heaviest of all! The speed of operating never seemed to depend on the operator but rather who he was working and the conditions. The courtesy of all of the hams was really great. If we heard a weak station and had only one or two letters of his call the rest of the pile-up would stand by when asked. We were, of course, interested in making a fairly good score in the CQ WW DX Phone contest during our stay as well as giving many a "new country".

It was late at night, when conditions were poor, that we wished for a linear to compete with the South American stations with the higher power and a better multiplier advantage in the contest scoring. Some of the late night DX we did work on 40 SSB was VQ9AA/D Don, CT2YA, UA9DT, YO9CN, and others. Our power output was slightly reduced at night due to the line voltage dropping to as low as 80 volts, but the Drake TR-4s continued to perform even though the power supplies did get a little warm. The results with the vertical were really amazing, at times tests were made in which it equalled the signal of the 3 element beam. It is difficult to compare two antennas unless they are both operating under optimum similar conditions. The vertical was used with an excellent ground system out in the clear on the wet salty beach. The height of the beam was limited and close to the buildings. But these were typical conditions. If you compare the trouble of getting a 3 element beam up in the air, rotating it, and keeping it up in the air to the ease of erecting the vertical you will pick the vertical every time. But then again, how about that extra gain of the beam under poor conditions? If you are activating a rare country, the rest of the world will look for your signal, weak or strong. But if you are also interested in scoring in a contest, the big signal helps. Sunday afternoon came too quickly for us as we had to shut the rigs down to catch our return plane or else remain on the island 4 extra days to wait for the next plane. We had to lose 5 hours of "prime" operating time in the contest because of this, or as Dick, WA4WIP put it, lose 600 QSO's . . . . . .

Upon arriving back home we found the second phase of a DXpedition, the QSLing with 200 QSL's the first day. The mail brought several dozen a day for the first month. Now several months later we are still receiving one or two a day. All of those who sent a Self-Addressed-Stamped-Envelope along with their card were answered as soon as received after the cards were printed. Those who did *not* send a SASE, well, lots of luck, don't be in any hurry for your ZF1EP QSL as they will go by the QSL Bureaus. To those who think DXpeditions make money from all of the contributions sent with the QSL, forget it. Out of the first 1000 cards received, the contributions totaled $10.00. To those 1% we send our sincere thanks as it did help pay for the QSL cards.

In conclusion, a well planned DXpedition, with good equipment, can be a very enjoyable experience. This group is already planning for another trip to another country in the next few months. We hope it might be a "new one" for you. So that others might get the DXpedition "bug" and activate countries that *we* need, we dedicate this article.

. . . W4PJG

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How is your Club Paper? Good or Bad?

There are two categories in which papers can be classified. Either they are good or bad. Bad papers have no business to be published as they serve no definite purpose. If your club paper depends on gossip, bits of wit or other nonsense to fill space, your club would be better off ceasing publication.

The reason for having a good paper is to furnish the membership informative news, technical information, projects and activities so that it can be a good communication link for the club membership. Very frequently papers of this type help to interest new members for your club.

Club papers should be planned like a good magazine or newspaper. It must have a set format, good composition, interesting material, appeal and appearance. Many editors of amateur radio club papers follow such planning and turn out excellent papers. These editors lay the ground work of their next edition at least two weeks or more ahead of publications. This gives them plenty of time to turn out a paper which is interesting and a credit to their club. There is plenty of material that an editor can have ready ahead of "deadline" so that he will not be pinched for time when publication date arrives.

Formats can be a credit to a publication and can be the difference between a successful publication or one on the skids. Many ideas can be checked by reviewing some of the national radio and electronics publications and *73 Magazine* is one of them. Formats by these publication editors are well planned and if used by radio club editors it will contribute interest and reader approval by your club membership. Formats need imagination and once you find one, stick to it.

Composition and material are two essential items to be considered with care. Layout of material should not be done in a haphazard way. Each item of interest should be in its proper place. For example, news of current interest about your club members should be front page copy. Following pages can have announcements of future programs, new F.C.C. regulations, biography of your next guest speaker, editorials, swap lists, auctions and a technical corner. Each column should have a headline to set it apart from the one preceding.

Attractive mastheads are a must. This sets your paper apart from the "run of the mill" publications. Again be original with your ideas, don't copy others. If some member of your club does art work, assign him to the task of designing the masthead. A favorable idea would be to have a contest and to the member turning in the best design, a prize could be awarded. A master stencil could be made of the masthead and used indefinitely. Using a separate color for the masthead adds more zest and imagination here can go the limit.

The printing of a paper has a choice of process. It can be mimeograph, hektograph, offset or letterpress. Using a mimeograph or hektograph process is the cheapest. Many clubs use either of these and have their own machines. In commercial printing, offset is the cheapest; although letter press costs more but has the quality. Letter press is processed by linotype or by hand and, due to labor cost, it is more expensive. Pictures can be reproduced with letter press with excellent results, should you feature them in your club paper. The process for offset printing is by photographing copy of the club paper. It is used by many clubs who wish that professional look. Commercial printing should be given consideration as it adds prestige and in the long run, cheaper than "do-it-yourself" printing.

How can the cost of the printing be raised? There are two angles to consider. First . . . is to increase the membership dues to pay for the cost of printing and the second is to have advertisers take space in your paper. This would take care of the added

expense of commercial printing. Your members can serve as advertising salesmen and a prize can be awarded to the member bringing in the most advertising. Who can be the advertisers? There is no limit to who is a good prospect for advertising. Local amateur radio supply stores, surplus stores, drive-ins, drug stores and many more are good prospects and will advertise for the good will it creates.

Rates for advertising has to be judged by the expense of printing and mailing your paper and the amount of circulation your paper has. A typical budget for figuring your cost and profit is hard to establish as in some sections of the country printing costs are either higher or lower than in your area. As most radio clubs are non-profit organizations, it would be wise to break even. If you have a profit there is usually a tax bite to even things out.

The editorial staff of a paper should be selected by the president. He should appoint a managing editor who possibly has had experience in writing or editing a paper. The managing editor should have full charge of the publication of the paper. He should have as his assistants, a production manager, a technical editor and an advertising manager. The production manager should have the responsibility of getting the paper printed and mailed. The staff should meet once a month, before publication time and plan for the current edition. Each member of the club should act as a reporter and secure news and material for the paper. The managing editor can assign a member for each type of news media, i.e., Civil Defense, member activities, news happenings in the radio amateur world, contests and projects: In plain language, it takes a team to make your club paper a success.

Editorials by the managing editor makes interesting material and if the subjects are timely, it can put spice into the paper. The editor should select subjects which are of interest to the whole membership and avoid out-and-out gossip or witticisms. There are great many subjects which can be discussed about amateur radio or your club, and it is not necessary to list them all here.

It is suggested that the club paper be protected by a notice in each edition stating "This publication or any part of it cannot be reproduced without the permission of the club". This protects your contributors or any material in the paper. Many clubs favor

this practice and in some cases they copyright their paper. All national magazines usually copyright their publications. Look at page 1 of any copy of 73 *Magazine* and you will see the copyright notice.

A favorable habit among clubs is to exchange publications. Write to those clubs whom you feel have successful ones, offering to exchange yours for theirs. Reading these will give you an idea of their activities and projects, and may help your club to plan along the same lines. Another good idea for interchange between clubs is to have a column set aside for announcements of "what other clubs are doing". This creates good will and can be beneficial to all concerned.

Another suggestion is to get acquainted with the editors of club papers in your area. Interchange of ideas can be beneficial to all concerned. A state or local editors association can be formed which could meet frequently and discuss ideas to advance the art of publishing good club papers. There are state and local newspaper and magazine editors associations, so why not radio amateur clubpaper editors.

The facts and suggestions in this article are not necessary to carry out to the letter but the fundamentals are worth following if you want a paper which reflects the club it represents. Good papers are popular, bad ones are thrown in the waste-basket.

. . . K6GKX

Just got the chow call, OM.

M. Goldstein VE1ADH
9 Edgehill Road
Armdale, N. S.
Canada

G. Cousins VE1TG
RR 2, Box 18
Lower Sackville, N. S.
Canada

High Quality Hybrid Receiver

In these days of "commercialized" ham radio, there is such a variety of well designed and readily available equipment on the market as to make a home constructed station almost a thing of the past. This is especially true of the receiver, which has always been considered to be just a little outside the ability of the average home constructor. This view may not be justified, and this article will try to point out a few advantages to be gained by home-brewing a receiver. Let's briefly review the aims of this project:

1. A *good* SSB and CW receiver, to compare favorably with commercial units in stability, sensitivity, freedom from cross-modulation and overload.
2. Dial tuning should be smooth, with no backlash and no dial cords. Calibration should be very easily read in increments of one kilohertz.
3. Few controls and very simple overall adjustment.
4. Standard components to cut down cost.
5. Construction should require only standard home-workshop tools. Alignment should be accomplished with standard and readily available test equipment.

Throughout the whole concept of this project, the cost factor and ease of construction have been vital considerations as well as the overall quality of the finished product. To accomplish these features, both old and new receiver circuits were used. Many were obtained from *73*, *QST*, the *ARRL Handbook*, etc. Some modifications were made to mate all the circuits together, but the best features of each were retained.

The receiver is a combination tube and solid-state design with the basic range being from 3.5 to 4.0 MHz. For other bands, crystal controlled converters are used, so that the receiver can be constructed and other bands added as required. Each converter can be optimized for performance on one band, and each band is designed to cover 500 kHz. No doubt eyes will be looking skeptically at the idea of tubes in this "solid-state" age, but many of us still have a lot of tubes on hand and it seemed pointless not to use them. Neither space nor power drain were problems. Tube types were standardized to reduce both initial requirements and possible spares. Solid-state devices were used in the front end and oscillator circuits in the interests of stability, and of course, could be carried through into other circuits if desired.

Construction was done on two chassis of heavy gauge aluminum to ensure rigidity, good shielding between front end and audio *if* circuits, and also allow part of the receiver to be completed and tested as a

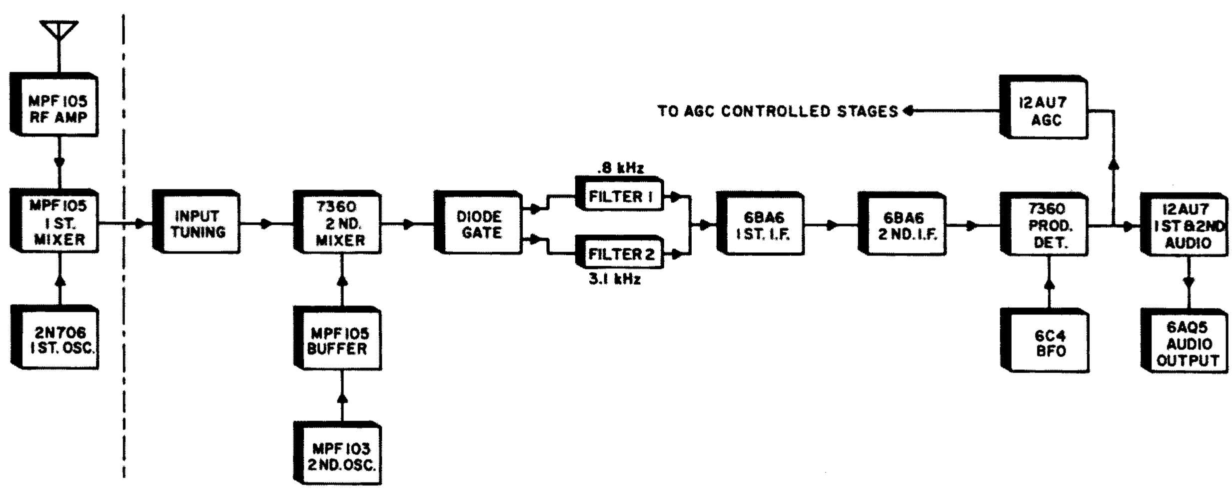
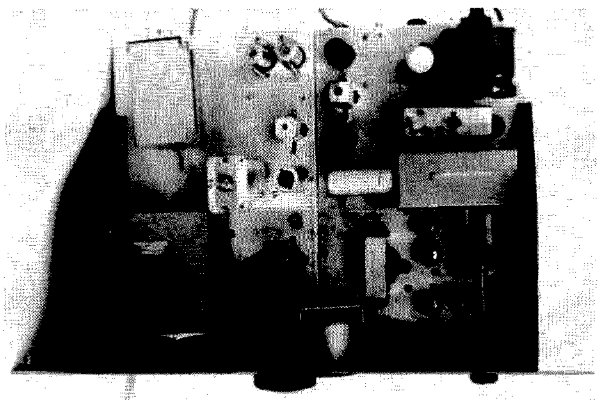


Fig. 1. Receiver block diagram (with plug in converter).



Top view of the receiver. Front-end circuits up to the mechanical filters are on one chassis, and *if*, audio, S-meter, BFO power supply on the other. Mini-boxes contain the oscillator tuned circuit, driven by the National dial, the BFO and product detector, with the BFO tuning shaft extended out to the front panel. A third box is shown plugged in to the converter socket at the rear of the chassis. This is a prototype 20 meter converter, but similar units could be plugged in for any band.

separate unit. In fact, the audio, *if* AGC, S-meter, BFO and product detector circuits could be built as a project in themselves and added to a less expensive receiver to bring it up to higher standards. The audio-derived AGC and variable BFO are especially useful for SSB and CW operation and could be built into a small sub-unit and installed in the present station receiver. Front panel controls are kept to a minimum. Separate gain controls are used for *if* and audio, and also front panel control of the BFO over a frequency range of plus and minus 2 kHz of the 455 kHz *if*. For the main frequency dial, the National NPW dial and drive mechanism was chosen. It provides smooth operation and slow tuning rate, but should first be lubricated with silicon grease. This leaves a thin film on the gears even after extensive use.

Using 000 on the dial as the low end of the band (3.5 for example, 010 indicates 3.510, 020 is 3.520, etc. Admittedly some little effort is required to achieve this tracking, but the result is well worthwhile. This eliminates the need for any other form of dial markings and gives a clear readout of one kHz per division.

The three-inch deep chassis gives plenty of room for neat construction. Liberal use of tie-point strips ensures firm mounting of components. Instead of lacing the cabling, small nylon loop clamps were used. This makes it easy to change the wiring or install modifications. Every effort was made to keep the wiring and components "in the open" to facilitate servicing.

The receiver was built from the rear end forward, so that the power supply could be used to test each circuit as it was built. The photo of the top of the receiver shows the mechanical layout. While not all *that* critical, it's recommended that not too much variation be allowed. The power supply uses silicon rectifiers in a bridge circuit, and supplies both regulated and unregulated B+. There are also voltage take-offs for the transistors and mechanical filter switching diodes.

To obtain regulated voltage for the BFO, a tap on R1 picks off 150 volts which is regulated by the Zener diode CR1. The diode shown is far larger than necessary, but it happened to be available. An alternate way would be to use a miniature regulator tube such as an OA2 or even one of the octal VR150's.

Voltage for the mechanical filter switching diodes is obtained from the 6.3 volt filament transformer, rectified by CR2, and filtered by C1, C2 and R2 to provide a negative voltage output for controlling the diodes.

Positive voltage for the same diode circuit, and for the transistors, is obtained from B+ via R3 and R4, the latter being a 25,000-ohm pot (2 watts), which is adjusted to provide the necessary +12 volts. This pot is a one-time adjustment and is mounted underneath the chassis. A 12-volt Zener diode is connected from the arm of the pot to ground. This regulates the voltage and absorbs any transients.

This receiver has lots of audio, with a two-stage triode voltage amplifier driving a power output stage. Because of the considerable gain in the circuit, care must be taken to separate the grid and plate circuits and to find the best possible arrangement of components. The audio gain control is placed at the input of the amplifier.

The AGC circuit is quite standard and is found in the December 1965 issue of *QST*. The circuit in the *ARRL Handbook* for the past several years will work almost as well, and reference should be made to these sources for full circuit analysis. The S-meter functions whether or not the AGC is on. Because past experience had proven that different AGC rates were seldom used, no provision was made for them. The AGC on/off toggle switch is the only control required on the front panel. The associated *if* stages must

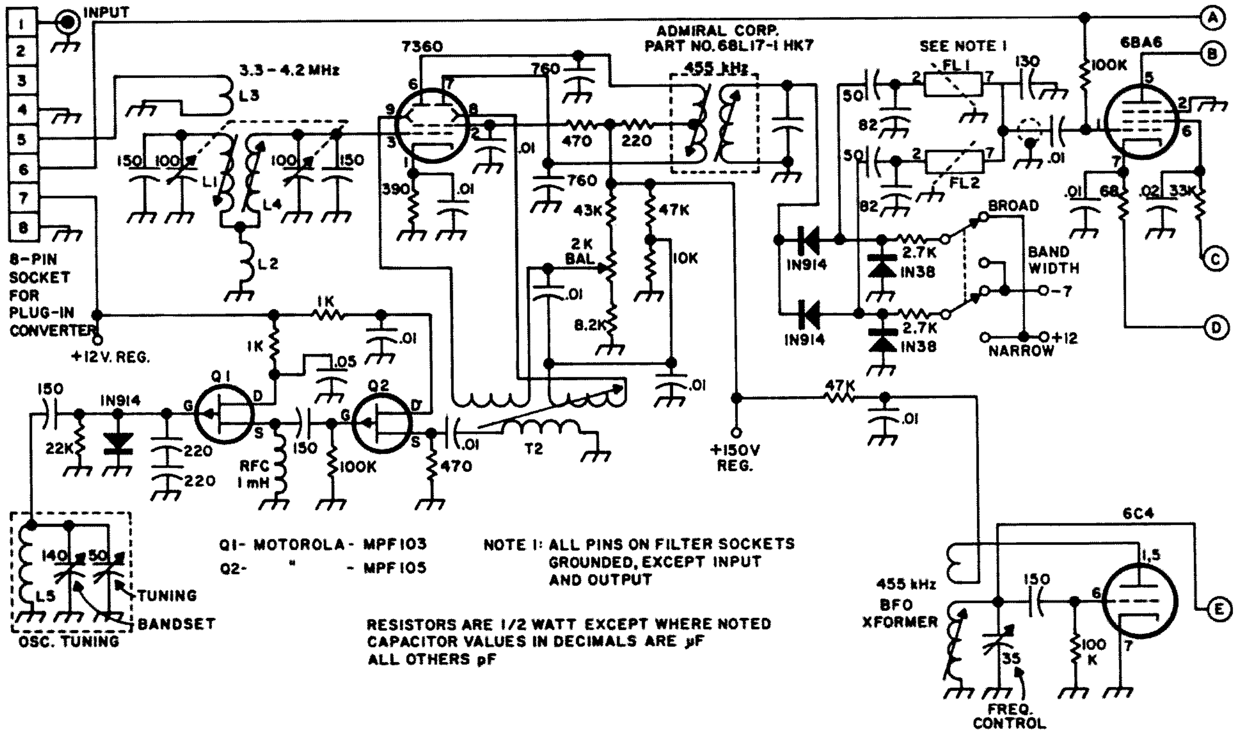
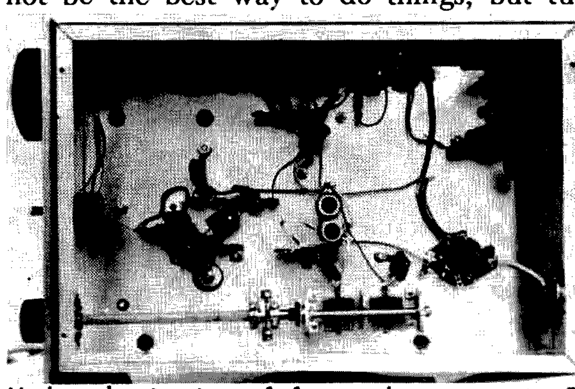


Fig. 2. Front End.

have their grids decoupled from the AGC line with large resistors and bypass capacitors, or even small RF chokes. Shielded wire may also be necessary for the AGC line itself. The S-meter is also adapted from the *ARRL Handbook*, and in this receiver it is not a calibrated function of signal level; it is merely used as a reference indicator. Considering the multitude of ideas about the calibration of S-meters, this is probably just as well. The circuit uses a single 6C4 triode and a milliameter of one to five milliamps full scale deflection. The adjusting pots are mounted on a small plate under the chassis. To do the initial set-up, pull out the 6C4 and adjust the meter shunt pot for maximum deflection on the meter. Replace the tube, short the AGC to ground, and adjust the 6C4 cathode pot for zero meter reading. Remove the short from the AGC, and the meter will now follow signal variations up to the point where the tube's plate current is cut off.

For solid-state fans, the January 1967 issue of 73 has an excellent article on an equivalent circuit using a field effect transistor. Any other circuit which may be contemplated must have a very high input impedance to not effect the AGC time constant.

The 455 kHz *if* strip uses 6BA6's in two stages of amplification. The main feature here is gain; the selectivity is determined by the Collins mechanical filters which come before it. An *if* gain control is provided, and short shielded leads should be used for stability. In-line mounting of tubes and *if* transformers ensures a neat wiring job. Good quality shielded transformers should be used. Referring to the photos, notice that the BFO and product detector tubes are mounted sideways and butted up against the side of one *if* transformer. To overcome the problem of changing the tube, the *if* transformer is held in by two screws and has long enough leads to enable it to be unscrewed and tipped over while the tubes are changed. This may not be the best way to do things, but tube



Under chassis view of front-end components. The dual-section input tuning capacitor is coupled to an extension shaft, to keep it physically close to the input transformer. The octal socket is for the plug-in converters.

changing will be rare and the constructional advantages were considerable. Incidentally, the "long enough leads" should only be about 1½ inches or so.

The product detector uses a 7360. Both it and the BFO are built into a small metal box, with the tubes mounted on one side and the BFO transformer on the front. To make the BFO frequency variable, a small tuning capacitor is mounted in the box and the shaft extended out to the front panel. The box prevents any external coupling between the BFO circuit and the *if* strip. It is firmly bolted to the chassis and all leads to it are brought through a grommet-lined hole in the chassis. If a variable BFO is not wanted, a crystal-controlled unit could be used. The circuit must have good sine wave output of at least 10 volts peak-to-peak. A transistor circuit would work just as well. A vernier dial is used on the BFO control to give a slow and precise tuning rate, a necessity for crowded CW conditions and of considerable help in SSB reception.

The selectivity of the receiver is dependent upon the two mechanical filters which have been chosen as 3.1 and .8 kHz for SSB and CW use. The filters plug into miniature 7-pin tube sockets, and small copper shields are installed directly across the sockets to separate input and output circuits. All pins on the socket are grounded except the input and output. Switching the filters is done by means of silicon diodes.

The mixer circuit is taken from the September 1963 issue of *QST*, and uses a 7360 tube. All supply voltages are regulated and the output is fed through a special coupling transformer to the mechanical filters. The transformer used is an Admiral Corporation part number 68L17-1 HK2.

A pair of Motorola field effect transistors are used in the oscillator. The coil and tuning capacitors are mounted very rigidly in a separate metal box, and all connections made with heavy braid. The capacitors should be very good quality, double-bearing units. Such precautions will pay off with a very stable, low-drift circuit. A second transistor stage provides good isolation between the oscillator and the output to the mixer. The balanced output transformer is home-made, wound on a Millen ½" slug tuned form. Dimensions are given in the coil table. Tests indicate approximately 100 hertz drift during the entire warmup period. Good mechanical stability is indicated by the time-honoured "thump" test.

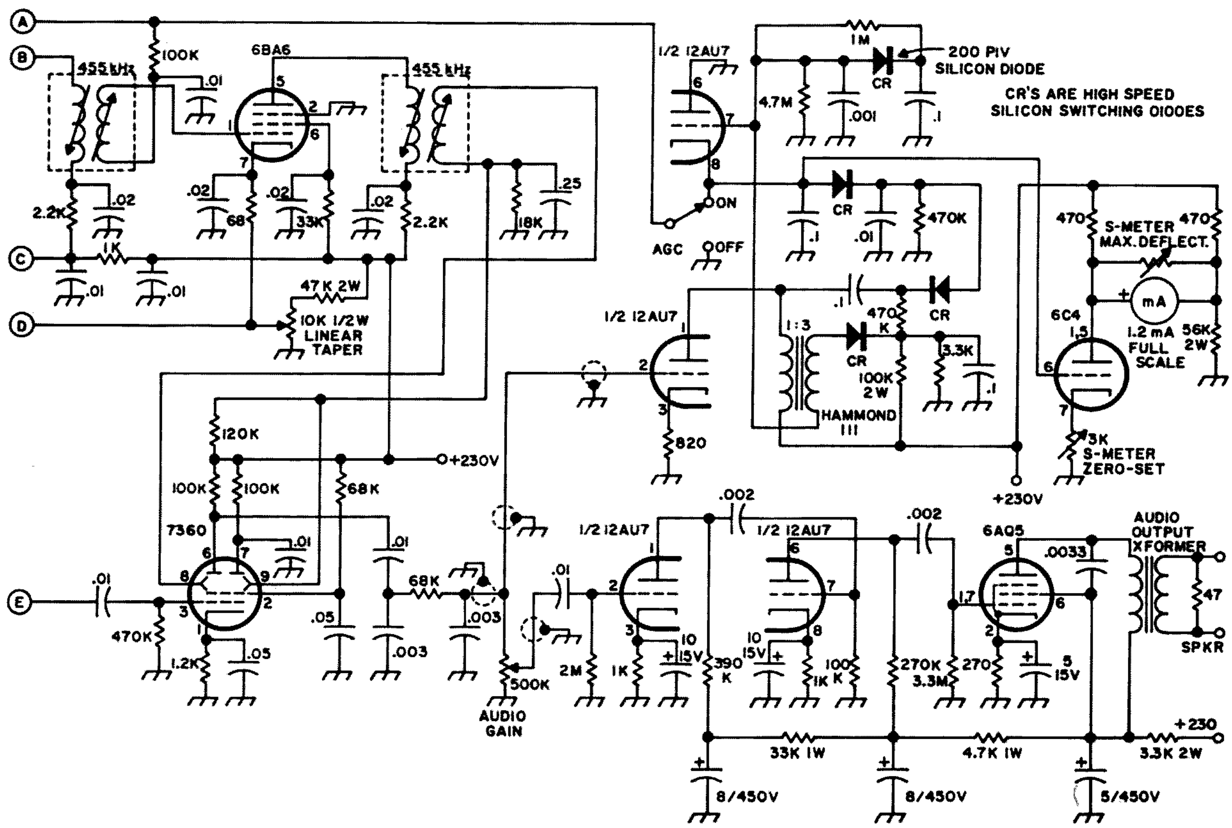
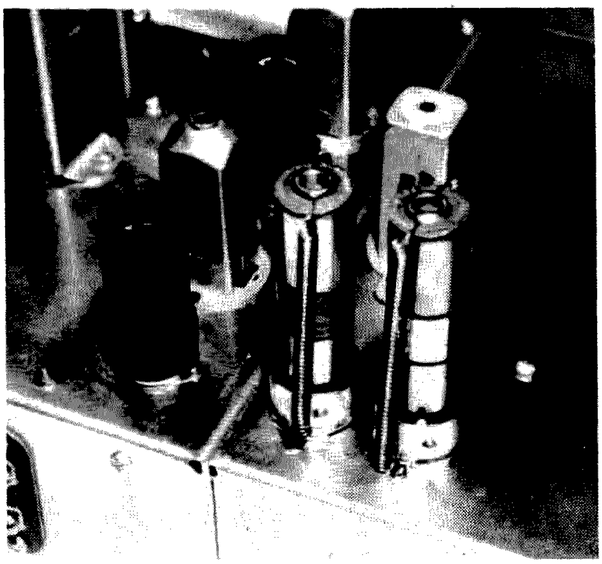


Fig. 3. Complete schematic diagram for the hybrid receiver.



The Collins mechanical filters are shown in their sockets, with spring retaining clamps. The *if* tubes and transformers are immediately to the left of the filters.

Note that there is no rf stage. An octal socket arrangement provides for the use of plug-in converters, and an rf stage can be built on a separate module and plugged into this socket. This will not likely be necessary for good 80 meter reception, of course, the converters will have their own rf stages. To align the receiver, use good test equipment. Items required are a VTVM, an rf Signal generator, and a scope with 5 MHz bandwidth. Do the alignment in the following order:

A. Power supply: Check voltages. B+ should be approximately 230 Vdc. Regulated voltage +150 Vdc. Adjust the positive low voltage to 12 Vdc. The negative low voltage should be approximately 7 Vdc. Test the power supply without the circuits connected

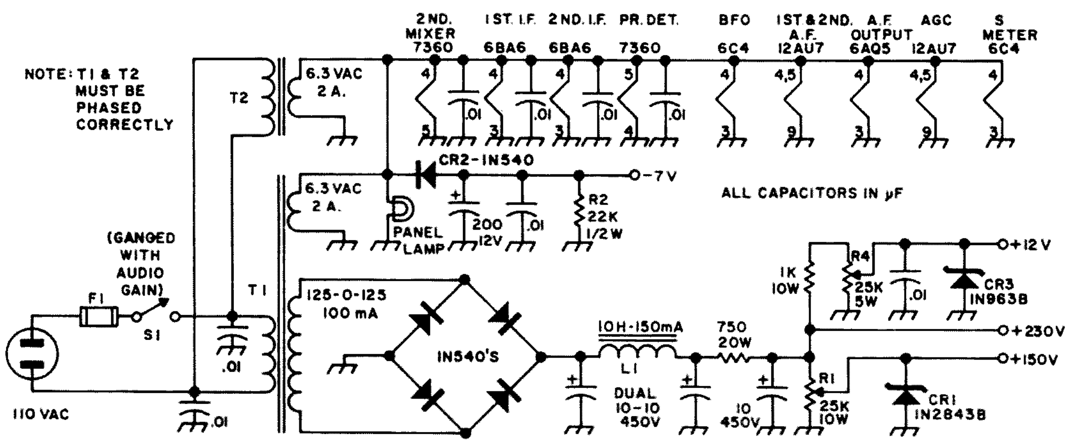
Coil Table

L1	30 turns #30 cotton covered wire, on Millen 69046 slug tuned form.
L2	1½ inches of #18 wire between junction of L1, L4 and ground.
L3	15 turn link wound on cold end of L1.
L4	30 turns of #30 cotton covered wire on Millen 69046 slug tuned form.
L5	17 Turns #18 wire, ⅞ inch long, 1¼ inch diameter. Barker & Williamson 25 watt 40 meter coil with link removed, and 5 turns removed from each end. Inductance 8 microhenries.
T2	Primary: 60 turns #32 enamelled wire. Secondary: two windings of #32 enamelled wire, 35 turns each, wound over the primary, on Millen 69046 slug tuned form.

to it, and be sure the above voltages are maintained as more circuits are added.

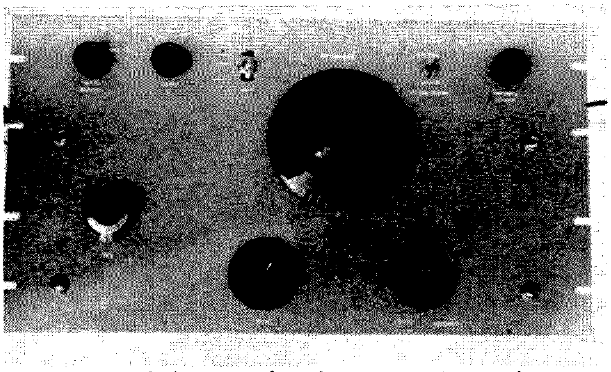
B. Audio section: An audio tone injected at the top of the volume control should be heard without any distortion in the speaker. The S-meter should deflect. Calibrate the S-meter as previously explained. The hum level should be extremely low.

C. *IF* strip: Remove AGC from the strip. Turn the *if* gain control to half position, pull out the first *if* tube, and connect 455 kHz from the signal generator to pin 5 of the first *if* tube socket. Connect the VTVM to the AGC line. Align the last *if* transformer for maximum reading on the VTVM. Replace the first *if* tube. Remove the *if* strip input from the mechanical filter. Inject 455 kHz through a .01 F capacitor to the grid (pin 1) of the first *if* tube. Align the first *if* transformer for maximum on the VTVM. As alignment proceeds, keep the output level of the signal generator as low as possible. Reconnect the AGC line to the *if* strip and remove the VTVM.



NOTE: ALL CAPACITOR VALUES GIVEN IN μF

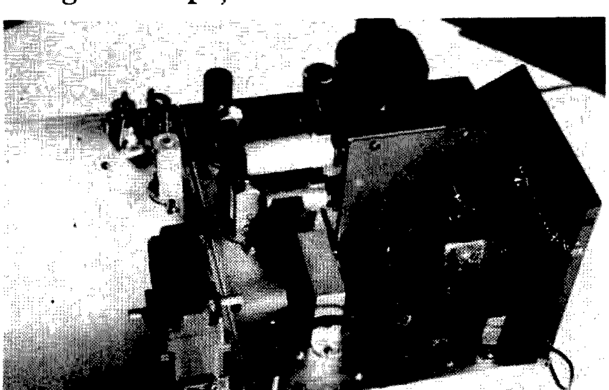
Fig. 4. Power supply for the High Quality Hybrid Receiver



Front view of the completed receiver. Note that controls are kept to a minimum. The S-meter and clock are on opposite sides of the dial illuminating light. A small metal shield normally covers this light and directs the light down to the dial markings. A vernier dial is provided at the right for the BFO tuning capacitor. Bottom controls are: antenna input tuning, mechanical filter selector switch, AGC on/off switch, *if* gain, and audio gain/power on-off. A National NPW dial is used for main tuning.

D. Oscillator, mixer and BFO: Disconnect VFO output transformer from the source-follower transistor. Disconnect pin 3 of the second mixer tube (7360) from its input circuit and ground the grid through a 100,000-ohm resistor. Connect 455 kHz signal to pin 3 via a .01 F capacitor. Adjust the 2000-ohm balance pot for equal voltages on pins 8 and 9 of the 7360. Use the VTVM for this measurement. There will be approximately 35 volts on each pin.

Connect the VTVM to the AGC line. Check that the filter switch circuit is working and the filters themselves are operational. Adjust the 7360 output transformer for maximum reading on the VTVM. Reconnect the VFO output transformer to the transistor. Using the scope, check the source terminals of both transistors for approximately 2 volts peak-to-peak of good sine wave output. With the scope at pins 8 and 9 of the 7360, adjust the VFO output transformer for equal ac voltages on the two pins. This will be about 3 volts peak-to-peak.



Front panel removed, and the first chassis all mounted and ready for wiring. The mechanical filter sockets are at the rear, behind the dial gear box. The *if* tubes and transformers are in a row along the division between chassis. Audio and S-meter tubes are at the front.

At the BFO, adjust the vernier control to put the capacitor at half mesh. Adjust the transformer in the BFO circuit to zero beat on the test signal. Disconnect the 455 kHz input signal from pin 3 of the 7360, remove the 100k resistor from pin 3 to ground, and reconnect the tuning circuit to pin 3. Connect the signal generator to the input of the tuning circuit and set it to 3.6 MHz. Set the receiver dial to 100. Adjust the bandset capacitor for maximum on the VTVM (still connected to the AGC line). The signal should be heard in the speaker. Check the tracking of the receiver over the band. There should be very little error over the whole 80-meter band. Set the dial to 300, and the rf signal to 3.8 MHz. Adjust L1 and L4 for maximum on the VTVM. Remove the VTVM and signal generator.

This completes the alignment of the receiver. Signals should now be heard on the band and the receiver should be performing very well. Take some time to get used to the feel of the control and we think you'll agree the time and effort were well spent.

. . . VE1TG and VE1ADH

"How wonderful! I was afraid you might squander your unemployment check on groceries or rent."

Dr. Louis E. Persons, W4PJG
P.O. Box 1647
Ft. Myers, Fla. 33902

How to Get Better Returns from Your QSL

To obtain that wanted QSL you must first send your QSL, quickly and accurately. Immediately after the QSO sit down and write out the QSL. In this way you can check and double check on the date and the time in GMT. The *only* time to use is Greenwich Mean Time. If you are not sure of the correct time check WWV. Hams are one of the largest users of WWV, but when one sees the many incorrect times put on QSL's (and logs) it seems all they do is listen to the tick.

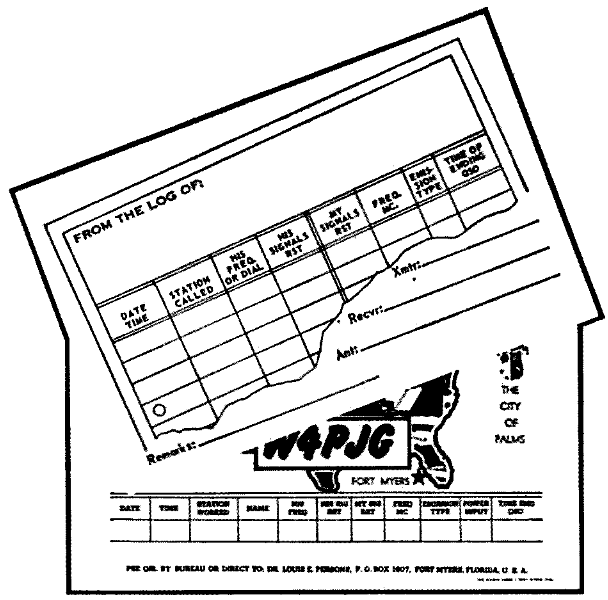
It may not seem important to be so accurate, but a rapid DX operator may work 2 or 3 stations a minute. If your time were off 30 minutes on the QSL you might well be 3 or more log sheets off. Your card might be returned marked "not in log". Make sure, if you are changing your local time to GMT time, to change the date also, if necessary. But why not keep the clock in GMT; it will confuse the XYL more. Hi.

The next most important item on the card is the band. Again, if you make the card out after the QSO you can take another look at the bandswitch to make sure. Many stations, in contests particularly, keep the logs by bands.

The mode of transmission is important also as many awards are for Phone, or SSB, or CW separately. The signal report is the next item of information necessary to complete the confirmation of the QSO.

It is unfortunate that there is not a standard form used for QSL design. The easiest design to read quickly is the log form type with all of the printing on one side only. The log form type is made up with a simulated line from the log sheet printed on the card. Everyone is familiar with the standard ARRL log books, so it is only necessary to recopy the line in the log to the QSL card in making out the card accurately. This type QSL may be obtained from World Radio Lab. and others. But whatever form is used, the call letters should appear on the side with the QSO information, so that constant flipping over of the card is avoided in searching the logs for the contact.

It has been said that a QSL is the final courtesy of a QSO. This is certainly true. QSLing is no burden to the amateur who works several stations a week, or even a day, but think of the station who is working 2 or 3 stations a minute in contest style. He is working in this manner to give as many as possible the chance for a QSO and



ultimately a QSL. QSLing for this station indeed is a chore. It is only right that we should assist this station in his QSL task in some manner. The usual considerate way is to send along with your card a Self-addressed-stamped-envelope. The SASE saves most of the work for the station in not having to address an envelope or card, and also the postage involved. If postage for that country is not available or obtained from W2SAW, then the correct number of International Reply Coupons (as given in the Call Book) are sent along with the addressed envelope.

Also, it is not asking too much to enclose a small donation to help cover the cost of the card or the gas for the generator in the case of a DXpedition station. Those

who go on DXpedition do so for several reasons. First, the enjoyment of travel and operating as rare DX. Second, to give the contacts to those who need them. The QSL is a necessary evil arising from the second reason. One on a DXpedition never expects to make any money on the trip or to even have his travel expenses paid. But somehow those who want the QSL's should assume some small expense involved. The cost of printing a decent special or picture QSL to do a DXpedition justice is around $20 per thousand and much more in other countries. It is certainly not asking too much to enclose along with the SASE a small contribution to help cover this expense, anywhere from a dime to a dollar is appropriate. While some hams revolt at the thought of "paying for a QSL" these individuals think nothing of paying to enjoy their other hobbies such as the green fee to play golf, the bait boat, gas, etc. for fishing, the film for their camera for photography and the cost of stamps for their stamp collection. QSLing is just one of the small expenses in enjoying the greatest hobby of them all, Amateur Radio.

When working a station ask him where to QSL or if he is working contest style, listen and he will announce every few minutes QSL information. If he announces the call letters only of the QSL manager or perhaps his home call be sure you have it correct. Then be sure that you look up the QTH in a *recent* Callbook. Recent is one dated the current year. If you do not have one which is recent, borrow one from someone else or look for the correct QTH in one of the magazines. The envelope with the QSL, SASE, and the contribution should be mailed by Air Mail if going out of the country. There are many other secrets used to obtain QSL's such as writing a letter to the station, along with your card in his native language, enclosing pictures, commemorative stamps, and even to sending him a QSL already made out to you just waiting for his signature. Blank cards can be obtained for this purpose.

While the above mentioned procedures may seem elementary to many readers, all QSL managers will agree that most of them are violated daily on cards received. Take pride in your QSL and QSLing procedure and your results will be pleasing.

. . . W4PJG

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Tips for the CW Contester and DX'er

Equipment

Go as high power (to the legal limit) as your budget and facilities will allow. "Low power is all one needs for DX" is sour grapes and unrealistic. I have worked the East coast of the USA from Hawaii on 160 meter CW with 25 watts to a guy wire and have been on the receiving end of a chap in Arizona using 6 milliwatts on 28 MHz CW, but that's for the birds if you want to enjoy DX without waiting for that freak break.

Low power may be fine for the higher frequency bands but on the lower frequency bands it is a waste of time. Likewise, stacked arrays, long booms, and high structures are fine if you can afford them, but I have found that the mental strain in a wind storm is not worth the price. Frankly, there is little to choose between a quad and a Yagi as long as you have some kind of a Beam with reasonable radiation efficiency. I have been through many cycles including stacked four over four beams, rhombics, and 45 foot booms, some of which are described in the antenna handbook and magazine articles.

A good receiving location is more important than long booms and superheights or yagi versus quad arguments. Let's face it, some of us are not situated to work DX.

Would you care to compete in the Indianapolis Classic in your family car? Get the best there is that you can afford, either homebuilt or commercial made. The qualities to look for in a CW receiver are controllable selectivity, fast recovery and freedom from front-end overloading. My contest contacts jumped a good 25% when I switched from conventional *if* to mechanical filters.

Lest you think that I am a button pusher, let me say that I entered the first few DX contests with a microphonic 201-201-112 combination in which one did the fine tuning by body English (leaning forward and backward to the right position after each transmission). Later a National FB7 was used which had only ¼ inch (not misprint) of bandspread for the whole 20 meter band. There was no such thing as zero beating a station because one couldn't find zero beat. However, for those who were fastidious, one could shut off the plate voltage and by holding the key down and letting the filament voltage provide a 60 cycle buzz of a sort, one could get near the correct frequency (wavelength in those days.).

To zero or not to zero

In CW work there is no choice but to zero beat. Listening up five (or ten) merely serves to clutter up the band. How would you like to work in a net in which each station was on a different frequency? A party line is what you want, so that everyone knows what is happening and where he stands.

The average CW man is smart enough to learn very quickly which way the wind is blowing. It doesn't take him long to find out that he is making an ass of himself by getting out of phase.

A good operator can take complete control of a frequency. I have heard operators who spend more time complaining of the QRM on *their* frequency, and trying to line them up in proper numerical order, than working them. If the QRM gets out of hand, one can always get out from under and sneak up on a new frequency.

Work stations and reduce the pile in natural order, the loudest ones first (with exceptions mentioned later) and get rid of them so you can work down into the weak layer. If you find that they are all about the same strength, tune off to one side just a little (something you cannot do with SSB very far). It is very seldom that everybody will be exactly on the same frequency. Work slightly around the edges of your

frequency and back and forth across your frequency. Let your ear separate the slightest frequency differences. If you cannot do this you need more practice.

The operator

One must keep in condition to be able to work a successful contest. Be able to copy 50 words per minute in your head and to take down 35 words per minute solid. Logkeepers and spotters are a waste of time and as necessary as the fifth wheel.

The bottleneck is not spotting or logkeeping, but the operator on the other end. You can catch up on your log keeping while the other operator is sending. You will find ample time for logkeeping and other bookkeeping chores while the other fellow is sending, except when you hit an operator who has been around contesting a lot. If you meet two or three of these fellows one after another you will find yourself three or four contacts behind in logging. However, there is a trick in this situation too. Simplify your numbering system, what difference does it make to anybody whether you pass out a 599 or 579, you might as well give them all 599. The chances are he will also give you a 599 so why complicate bookkeeping. Moreover, a good report makes the other operator think that he is getting in loud and clear and will make the contact short and fast.

To squeeze out that weak one employ the following technique. Hold your breath, close your eyes, cock your head and concentrate. Incidently, I have found that this works for hearing tests as well. I presume you use earphones, because if you use loudspeakers you are not a CW Dx'er, note I didn't say phone Dxer because quite a number of hams apparently don't know that one can monitor the quality of ones transmission by using earphones and your own receiver. If you use a transceiver, of course you are out of luck.

The stethoscope type of earphone allows you to wear glasses in comfort since you will be operating for 8 hour stretches. The old earmuff type (Brandes, Baldwin) phones made your ears feel as if they were ready to drop off after a few hours of use.

When your contacts start falling off to less than 30 an hour, it is time to catch up with a catnap. Get a good rest of at least six hours every night.

Special techniques

Unless you can get into the dense ham population area you might as well forget about becoming one of the top scores. In the ARRL DX Contest, this means that you must put in a good signal into the second and third call areas for at least 14 hours a day. There seem to be a lot of W6s but you will find that they get fished out very quickly. The second and third districts will furnish an inexhaustible supply of weak ones.

If it is a world-wide competition (CQ type), unless you are situated to work into Europe, you are not going to be among the world high. The South American CW contester is a rare bird, and you can't get many CW multipliers from the North American continent.

Know when special openings are going to take place and be there with proper schedules, Special openings sometimes are of only a few minutes duration. For instance you can work that W1 on 160 meters just as the sun in rising on the East Coast. He will peak up and rise out of the noise level and disappear again only once.

On the low frequency bands, don't get sucked in by the first loud station who calls you. He can serve a useful purpose by using him as a bait. Let him call you but don't answer for a while. His cry of anguish will alert the band to the fact that something interesting is underneath. When the pack becomes thick, pick them off one by one. This technique will save a lot of CQing on your part on the low frequency bands.

However, certain non-DX types will fool you because he gives up easily and quits after a few calls. Cultivate a clientele and learn their habits and foibles. You will find that certain ones will always be there as soon as you open up on the band. Make a habit of opening up on a certain band at a set time, the old timer contester will be there waiting for you. W9IOP, W4KFC, W3MSK, W3GRF, W6RW, to name a few, don't get rattled easily. They will quit if they don't get you in the first few calls, knowing full well that their time will come around when the hue and cry subsides. Learn to recognize fragments of familiar calls.

Don't fold up in the face of competition, the opposition can always blow up a power transformer or have a social engagement

the second weekend. Don't show your hand but keep the opposition guessing, and in this respect serial number sequences are less desirable since it involves one more type of bookkeeping. Multipliers will take care of themselves if you pile up the volume.

Do not keep the other station guessing by changing pace. Set up a definite sequence and stick to it. Deviation from a sequence or change of pace only serves to confuse the operator at the other end. When you go back to a station, his call will be lost in a pile of QRM and he will know who you went back to. Therefore it is important that you reassure him by signing his call at the end of an exchange plus your call. Signing your call at the end advertizes your presence on the band and prevents queries as "what is your call?" Sign your call only once, no more, after all, they know who is being hunted. A mere "break" only serves to get several other stations acknowledging you, each one thinking that he has nailed you.

Learn to copy a fast sender through a slow sender. Many times you will find that someone who calls very slowly will be in harness with a fast caller. Get rid of the fast caller with a fast exchange and then go back to the slow one. He won't know the difference. If the slow caller (long caller) unexpectedly signs early, a short "QRZ" will keep him going for another round until you are ready for him.

Sometimes you will find two stations sending you a serial number each thinking that he has mailed you. A short "ok" at appropriate intervals will hold both for you until you sign out both calls. However, this last trick calls for considerable practice and finesse because you can get into an awful mess by losing synchronism.

Logkeeping

Use carbon paper and send in the carbon copy (FCC says you must keep original logs.) The standard ARRL logbook is good for only 29 contacts per page and is not recommended for contests in the order of 4000 contacts.

It is amazing how well one can keep track of duplications after a few years of practice. The average contester has a pretty foolproof filing system so let him do the work for you. You will not have time to keep track of multipliers at first. Leave that chore to a slack period. You are less liable to make mistakes this way.

Hang on to that ballpoint pen at all times and don't lay it down. Learn to send on the bug while holding the pen in the same hand. The other hand can be arranging papers or adjusting controls while you are sending. Can you imagine picking up a pen and laying it down 8000 times which is what one would do in the course of a good hot contest.

A parting shot

Over 8000 contacts were made in the 1967 ARRL DX Contest from a 5000 square foot city lot using a tribander and antenna system described in a recent magazine article with a 40 foot tower from 160 meters through 10. Tower guy wires were used as radiators for the low frequency bands. For the contest antagonist, let me say that I have been through the public interest and necessity bit. Ask any old timer about the relay circuit from KA1HR (Manila, OM1TB (Agana) to NY2AB (Coco Solo) to W3CXL (Washington DC). There was none of this "a phone match is in progress and a clear channel will be appreciated" stuff. Message traffic ran up as high as 4000. Traffic handling, ragchewing, net operation, RTTY, VHF, have been tried but there is nothing like a good hot DX contest to test men and equipment.

. . .KH6IJ

Ross Sheldon K4HKD
3313 Avery St.
Huntsville, Alabama, 35805

How to Publicize Your Club

I've never met an editor, nor even seen one—except in "B" movies. But, as a retired army public relations officer and a part-time freelance writer-photographer, I have had no difficulty getting publicity stories into print, without coming any closer to the editor than my mailbox and his. They don't ALL get printed, but MOST of them do.

The only problems I have had with getting stories about the Huntsville Amateur Radio Club into the newspaper and onto the radio are two: Getting the club members to do something worth writing about—and getting up the energy to write it up and drop it off at the local papers and radio stations when there is a good program on TV or the DX is rolling in.

And that last is the principal obstacle to most club publicity chairmen in getting up a good story—getting up the energy to get it out.

But, lest someone say: "It's easy for a pro to talk", let me show you how easy it really is to get publicity—yet how difficult it really can be, if you don't understand a few simple facts of life about public relations.

Fact Number One: The editor *wants* to print your story.

An editor's favorite dream is of mailbags full of "good copy" sitting on his desk each morning; all well-written and accompanied by a stack of usable pictures. According to this dream-fantasy, all he has to do is shuffle through the pile, pick out those he likes the best and hand them to the copyboy to take to makeup.

Fact Number Two: There are a lot of people in this world trying to make his dream come true—for free.

Each day the metropolitan newspapers receive mailbags full of handouts from every imaginable source, mailed by public relations men trying to get their clients business into print.

Cypress Gardens deluges editors with pictures of sweet young things on water skis. Miss Pickle Week peeks out of another envelope sent by the public relations firm representing the pickle account. A picture of the town mayor signing a proclamation for "National Boy Scout Week" in company with the local scoutmaster and a toothy scout is next. And, as for the government: "Private Schnertz, son of Mr. and Mrs. J. J. Schnertz—"! The departments of Agriculture (national, state and county agent) give the editor twice as much farm news in a day as he has room to print in a week. Every government agency, official, office-holder (or candidate for same) has an "image" to project.

And anybody who is *anybody* who comes to town, or just passes *through* it, has an advance copy of the event on every editors desk three days ahead, complete with pictures.

The moral to both Fact Number One and Fact Number Two is Fact Number Three:

The editor wants your story, but it had better be good; because, friend, it's got a *lot* of competition.

Now to give the editor what he thinks is good, what does it take—a degree in Journalism or English Composition?

Well, it *would* help if you could write.

But writing the simple routine news story of club activities is simple. Every ladies club has someone doing it. Take any club meeting story from the daily paper; scratch out the names, dates and places; substitute those for your own club; retype and send it in and you have as good a routine club news story as anyone else.

Maybe even better, if you get the facts straighter, the names spelled right, type it double-spaced with wide margins and have your name and phone number at the bottom in case the editor has a question he wants to check out.

Get these routine stories in from one to

two days ahead of the meeting. It takes time to select, edit and print them—and there is no filing cabinet by the editors desk to "hold until release date". (The editor knows he will have a new slush pile tomorrow anyway.)

But these routine stories are the *least important* part of your job as public relations man for your club. Your main job is the clubs relations with the public; And the last thing the public wants to know about is that you held a meeting, or what went on in it. They don't belong to your club and could care less. What the public wants to know is—what is your club doing of interest to *them*?

Is your club doing anything which *affects* the public or is in the public interest? Is it doing anything the public would find interesting, informative, entertaining or from which the reading public could benefit in some way? Can any eye-catching picture be used? (Remember Miss Pickle Week and the young lady on water skis? What was *really* "newsworthy" about them? Nothing at all. Many "beauty queens" are non-winners of contests which never happened, merely paid models to advertise a product or an event the public is expected to pay for.)

Getting such "angles" to "make a story" is the public relations man's principal preoccupation.

And the principal problem associated with this is getting the club to go along with the story. Many club members do not realize that to be in the news they must be newsworthy; *they must do something worth writing about.*

To give you and your club ideas for opportunities to present your club and hamdom favorably in the press, following are some headlines from the local papers about the HARC—with a summary of the story that accompanied them. All stories included the time and place of the clubs meeting and used pictures wherever possible.

"Hams Donate Library Book"

Picture of a club representative and the city reference librarian examining the latest issue of the Callbook which the club donated to the library. The story explains that any ham may phone the reference desk and the librarian will give him the address he needs. The meaning of ham calls and how they differed from CB calls was included in the story.

"Hams To Help On UNICEF Drive"

The HARC "Spook Patrol" (see 73, Nov 67) is a regular Halloween event. The story tied in with the national UNICEF drive held at the same time.

"Hams To Promote Mobile Frequency"

A picture of a Sixer under the dash headed a story on how hams used a special high frequency for local emergency nets. Radio wave characteristics, low cost of VHF equipment, hams tie-in with Civil Defense and number of hams in Huntsville ("more than rest of the state combined") were included in the story.

"Radio Club Members Practice Tracking Clandestine Transmitter"

A page-wide spread of pictures showed hiding a transmitter and followed a ham with mobile and hand-held "sniffer" as he went directly to it. The civil defense, national security and rescue aspect of the hams tracking ability was stressed.

"City Ham is State Champ"

A picture of the club member who placed highest in the sweepstakes receiving an award from the SCM.

"Ham Radios Early Days Talk Planned"

Talk by an oldtimer. Angle: Todays hams bounce signals off the moon, put up their satellites and talk as casually to a ham in Singapore as to one a 100 miles away. Progress made by the hams in developing communications over the years was stressed.

"Radio Club Demonstrates At The Mall"

Picture of demonstration stations operating inside the city's largest enclosed shopping center. Citizens were invited to send messages by amateur radio from the display area. The National Traffic System and emergency nets were featured both in the story and on posters around the demonstration. Moral: Public relations men use more than a newspaper to get the image of their client across to the public.

"Charity Drive Calls For Hams"
"Radio Club To Aid Project"

Another double. Both stories on the same subject. The March of Dimes asked our help—and the hams said ok. Two stories out of one a few days apart. Moral: When you milk your cow, strip her clean.

"Radio Club Plans Auction"
"Wonder If It Still Works?"

The last headline was under a picture of three hams examining a piece of surplus gear to be auctioned off. A pile of interesting gear in foreground and background made the picture newsworthy and got 10 column-inches in the small morning paper and 24 column-inches in the afternoon. The auction that Friday night was crowded! (Finagle note: None of the pictured stuff was actually for auction. The three hams worked in a local electronics store which stocked the stuff and the picture was taken in the corner of their warehouse!)

"Ham Club Forms Speakers Bureau"
"Ham To Speak To Sertoma"
"Camera Club To Hear Ham"

The first story listed some of the subjects various members were qualified to speak about (from flower raising to lasers). Later stories featured the ham's picture and subject, and, incidently,something about the club he was talking to. In the public relations trade this is known as "piggy-back", "coat-tail" or "free-ride" publicity. That is, you get in your licks by riding the other fellows wagon.

"Ham Aids Ship At Sea"
"Local Operator Helps Man On Ship In Atlantic"

A local ham was asked by one in New England on twenty if he could get a station in Mobile, Alabama to meet a maritime-mobile later that day. A seaman had heard his brother was in a Mobile hospital as a result of an auto accident. A directional call on 75 on the state frequency got a station up on twenty from, of all places and Glory-to-be-for-Alabama-publicity—the battleship "Alabama" in Mobile Bay! (Absolutely *no* Alabama newspaper editor would have refrained from printing *that* story—complete with a picture from the morgue of "the great battleship"!) Moral: Sometimes you just *can't* lose.

"Each Night Hams Sit Down To Talk"

With half a page of text and pictures of homebrewed fixed and mobile rigs, the feature story told of the nightly Alabama Single Sideband Net, the National Traffic System, emergency operations and mobile units. The low cost of home-brewed gear and the local club activities were stressed.

"Ham Operators Monitor Storm"

(See 73, June '67, p 117 "Ham Public Service and Broadcast Stations".) Frequencies of local and regional hurricane nets were given for the benefit of shortwave listeners. Local newspapers and radio and TV stations borrowed receivers and listened to the ham hurricane nets, giving them credit for their activities. Five local stations broadcasted daily tape-recorded reports by a local ham on what the ham hurricane nets were doing.

"Junior Ham Action"

Hearing of a CB Jamboree in town, I suggested we display our mobile emergency bus in the parking lot for the benefit of interested CB'ers. We then photographed three of our junior-high hams in the bus with a story whose lead said the kids "stole the show" at the jamboree! (Which they did, but the paper caught H—from the CB'ers for saying so!)

"Pool Efforts To Curb Accidents"
"Jeep Patrol, Radio Hams Join Memorial Day Watch"

(See "El Paso Roadblock", CQ June, 1961). Though from another part of the country, this is included to show a type of skullduggery a public relations man sometimes has to pull to get his client in print.

The local jeep-mounted sheriffs reserve were previously featured in the paper, with a statement that they were handicapped for lack of radios. I suggested to them that, with a long weekend holiday coming up, the sheriffs reserve and hams could team up with a highway safety patrol demonstration stakeout to prevent accidents and as a training exercise.

Both groups agreed, but an immediate impasse was reached.

Neither wanted to take the initiative to organize the operation. Each said: "If *they*

want to put it on, *we* will help *them*"!

So—I phoned the head of each group as a presumed agent of the other which was "putting on the operation" and asking them to help!

To "avoid a clash of plans" (each thought the other was doing the planning) I proposed that as hams were only "communications men" and the sheriff's reserve were the"police experts", that each stick to their specialty and the hams provide the communications for the sheriff's reserve which would conduct all other aspects of the operation. Pictures of ham mobiles and sheriff's jeeps side-by-side were in all papers for days in advance and when they were seen at highway intersections over the holidays the public held its speed down. (Result, there were no accidents or speeding tickets issued throughout the long weekend.)

Moral: Watch the daily papers for activities and problems of other groups and take advantage of a chance to do a little mutual backscratching—even if you have to sidle up to the other fellow to do it.

Many other stories, with pictures, were the usual routine: Field Day, code classes, hamfest, installation of officers, program topics, etc. All are ideas you can use in your club.

. . . K4HKD

Line Noise in the Heath Monitor Scope

For you who have a Heath monitor scope, a note on intermittent line noise. If you experience this, try turning off the scope while receiving a weak signal. A possible cause of this noise is due to the internal construction of the CRT. Checking the schematic, you will find that your transceiver output looped through the scope "hopefully" gives you the trapezoid pattern on transmit. On the receive mode, the scope uses its internal vertical amplifier. However, the capacitive voltage divider, found on the back panel (Xmtr Attn Switch) is in the circuit at all times. After several years of operation, the CRT on my scope became an intermittent cause of much dandruff scratching. After two days on the bench, I found that pin 10, a vertical plate, was arcing to pin 4 deep in the neck of the CRT tube. Cut back the sensitivity on the transmitter attenuation switch, and save $27.05 for a new tube.

. . . Ray Kashubosky K8RAY

Technical Aid Group

If you have a question which can be answered adequately through the mail, look through the following list of TAG members and write to one whose specialty covers your problem area. Be sure to explain your problem clearly and write legibly. Enclose a Self Addressed Stamped Envelope for a reply. Do not ask a member to design a piece of equipment for you. The purpose of this group is to assist the ham with problems he encounters in the course of building or trouble shooting.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transmitters and receivers, AM SSB, HF receivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on *any* subject.

Jim Ashe W2DXH, R.D. 1, Freeville, New York. Test equipment, general.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Don Nelson WB2EGZ, EE, 9 Greenridge Road, Ashland, New Jersey 08034, VHF antennas and converters, semiconductors, selection and application of vacuum tubes.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile, test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Theodore Cohen W9VZL/3, BS, MS, PhD, 261 Congressional Lane, Apartment 407, Rockville, Maryland 20852. Amateur TV, both conventional and slow-scan.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W8JRC/4 BSEE, 3120 Alice Street, West Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OGJ/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic

keyers, digital electronics, IC's, commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters, receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM, FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Howard Krawetz WA6WUI, BS, 654 Barnsley Way, Sunnyvale, California 94087. HF antennas, AM, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434–74th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Wintzer DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4, Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

David D. Felt WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors, SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB–HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Helmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

PFC William A. Youdelman DL4FK/WA6LRS, DSMA B-4, c/o HHB, 6 Bn, 61 Aty. APO New York, New York 09225. Invites questions from members of US Forces in Europe regarding licensing or any technical questions they care to ask.

Eduardo Noguera M. HK1NL, EE, RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America. Antennas, transmission lines, ast experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665.

Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

D. E. Hausman VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland, Oregon 97205. This group of radio amateurs will answer any technical questions in the field of electronics.

Martin M. Hellman K2TAJ
61 Scott Avenue
Staten Island 10305 N. Y.

A Grey Beard Writes

It is possible that this will refresh the memories of some, and it may remind others, that the things they take for granted, did not happen yesterday or the day before.

Occasionally, during a chat with someone, on the air, the door opens for a look back to the old days, of wireless. There are still a few of us, who have sharp recollections of how it was.

Sixty years ago, landline telegraphy was the best of all hobbies. It did not cost too much, and the idea of sending and receiving messages over a distance, via a single wire, gave us all quite a kick. If you could put together some simple parts to make a sounder and key, and find some bell wire, and an old wet battery, you were in business. In our locality, as it is now, in many parts of the country, there was always the rich kid, who could afford to buy ready made gear. However, most of us had to improvise, invent, scrounge, hustle, and sweat, for the things we needed. We learned the code, the hard way.

In the big city, lines usually ran from apartment to apartment, and across the street, to other buildings. I strung one line beneath an elevated rail structure, and up to the top floor of Smitty's house on the other side of the avenue.

I earned money collecting and selling bottles to liquor stores, delivering race result cards to the corner saloons, and was the general delivery boy for everyone.

There was no such thing as asking Pop for money to buy apparatus, anyone doing so, was asking for the back of the hand. Many people were still scared stiff after the panic of 1907. The scare persisted for a long time, and anyone who could save, did so, in spades. It was a hard school, and a very thorough one.

I visited the old neighborhood after fifty years, and could fine only two familiar names on the store fronts. The schools, the elevated railroad, the house I lived in, are all gone. The fire house is all that remains.

I had a momentary feeling of sadness, and wished I could go back to those dear days. And to shake that dull feeling of being alone, I went into a local watering place and had a drink of leopard's milk.

While resting my arm on the bar, I remembered the five miles to Mesco, where the sales clerk used the telegraph key to talk to people in other part of the store; and the Electro Importing Company at 233 Fulton Street. If you wanted anything in the telegraph, wireless, or electrical line, such as wire, tubing, sliders, binding posts, ear phones, castor oil for the special variable condensers; these two places had the stuff.

If you wanted to go downtown to buy or browse, you either walked, or hitched a ride on the rear of a brewery truck. Any money you had, was for more important things than transportation.

The causes of landline telegraphy going out, and the new art of wireless coming in, were, a magazine called "The Electrical Experimenter", and the catalogue of the "Electro Importing Company." That catalogue was a masterpiece of descriptive literature. It was filled with choice items, such as coherers, electrolytic detectors, tuners, wire, loading coils, galena, iron pyrites, and some marvelous looking receiving sets.

Books on the new art, were non-existent, and we gathered our ideas and knowledge from reading those two articles. For code practice, we listened to the Navy stations, and the few commercial stations.

I was impatient and wanted to go farther and faster in wireless. I first tried Western Union, but was turned down for some reason, I still haven't been able to figure out. It is ironic that they hired me as a relief operator at the local Maritime Observatory, at Quarantine, fifty years later. They needed a blinker operator.

I found a job at DeForest's plant, which was located on the Harlem River, near Highbridge. My job was sweeping up, and cutting wires to length, with an old paper

cutter. I did not stay long in that job, it was too confining, and besides, I wanted to see everything that went on.

The factory was in an undeveloped area, nothing but weeds and scrub trees surrounding the place. This made it easy for some fellows to throw parts out the rear windows, and come back at night to pick up the stuff. The bolder ones would slip an ULTRA AUDION panel under their shirts, and sneak it out during lunch hour.

Our parents were very strict, and we all knew the penalty for bringing home anything, without a good explanation of it's origin. Anything that smelled of thievery, meant a walloping.

One day, I scraped together six dollars, and bought a vacuum tube, with pigtails coming out both ends. It lasted three hours, and while it lasted, the gang came to my house at night to listen for recorded music sent out by DeForest's station. He was permitted to transmit music, after 11 p.m. and for a distance no further than 27 miles. Which was just the distance from New York to Ossining, where his engineer lived and worked. The one thing that annoys me now, is that I can't remember his name. The name Gowan, rings a bell, but I can't be sure.

From 1907 to 1924, more and more people worked on wireless research and development. DeForest held U. S. patent #879,-532 filed Jan. 29, 1907, and British patent #1427, filed Jan. 21, 1908, for the third electrode in a vacuum tube, which was mounted between filament and plate. As a result of this invention, direct wire telephony from New York to San Francisco was successful in 1914.

DeForest, Armstrong; and C. S. Franklin and H. J. Round, of England, worked on the discovery that a vacuum tube had oscillating properties.

Speech was transmitted from Arlington, Va., to Paris and Honolulu in 1915. The station used about 300 tubes, rated at 25 watts each, as oscillators, modulators and power amplifiers.

Armstrong developed a system for receiving radio signals in 1919, and he called it a Superheterodyne. Three years later he came up with Superregeneration.

C. W. Rice and L. A. Hazeltine, in 1920 and 1924, respectively, found ways to stop unwanted oscillations.

Finally, W. Schottky installed a second grid in a vacuum tube in 1919, and we know this as a screen grid.

If you attended the Radio Show at the Grand Central Palace, just before Xmas 1922, this is what you saw. A fine assortment of spark and arc transmitters; a new type of transmitting condenser by Dubilier; demonstrations of superregenerative receivers with loop antennas; iron core rf transformers; and some new ideas in synchronous rotary spark gaps.

Today, you can hit Pop for a few hundred bucks and rush right down to the nearest radio store, and buy a beautiful piece of gear, a half gallon or so, wheel it home in a taxicab, load up a brass door knob and you are a "HAM".

. . . K2TAJ

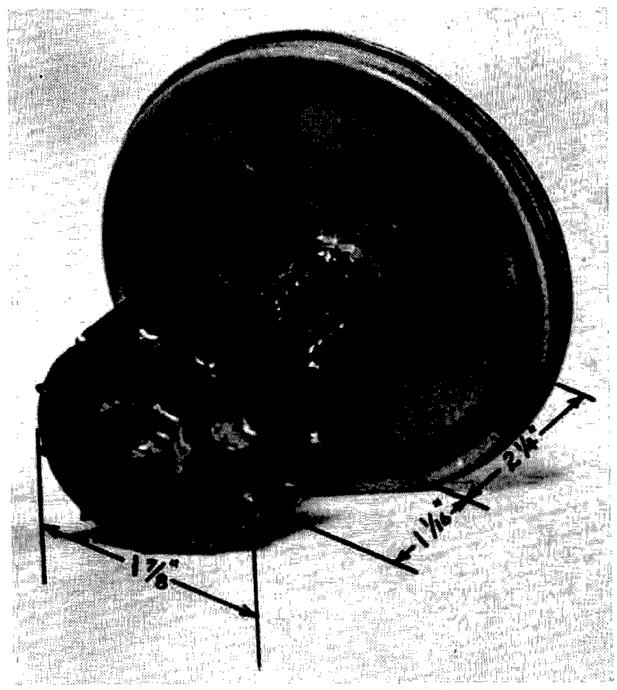
Bill Krause WA6OBH
1616 Roselawn
Stockton, Calif. 95204

The Quartenna

In my opinion, and that of many other hams, I'm sure, the Heathkit Cantenna is one of the best ham test equipment bargains on the market today. Its popularity is obvious from the number of articles propounding its virtues or suggesting modifications to further enhance its usefulness that have appeared in ham publications in the past few years. I would like to offer here a "modification" that will remedy what I feel is the Cantenna's greatest drawback—its size.

For those of us who run a full gallon to a rig complete with VOX, phone patch, antenna switching, and nice, neat hidden cabling, a Cantenna on the floor behind the operating console is the answer to the tuneup problem. But what about those of us who run a small transceiver set up on the kitchen table, or what about the VHF experimenter whose bench is already three feet deep with the latest project? For these hams the Cantenna is large—in fact, *four times* as large as it needs to be. The category I fall into is that of a VHF experimenter. As with most VHF operators, (we'll ignore the moonbounce and tropo scatter boys) I seldom have more than fifty watts of rf to handle from any one piece of equipment. It was with this need in mind that I came up with the Quartenna.

The Quartenna is essentially a 50 ohm nominal resistive element mounted in an oil-filled quart paint can. The resistive element is made up of ten 510 ohm 2 watt resistors connected in parallel to provide a 51 ohm load. Either a resistor value of 470 or 510 ohms is sufficiently close to the 500 ohm value which would make a perfect 50 ohm load. (I used 510 ohm resistors because my favorite surplus dealer has them for three cents apiece.) As can be seen from the photograph, the resistors are mounted between two 1⅞" copper discs in a 1¾" circle. This spacing allows the cooling oil to circulate between the resistors. Be certain to maintain at least 1/16" clearance be-



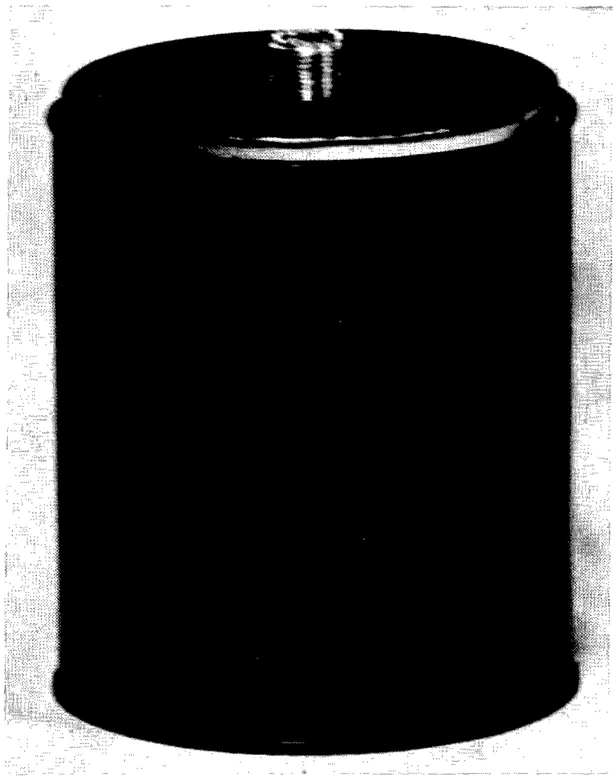
tween the resistor bodies and the discs; this minimizes the mechanical stress and strain on the resistors caused by heating and cooling. The center of the bottom disc is drilled to accept the center conductor of the coaxial support. The top disc is drilled and filed out to ¼" to accept the outer conductor of the coaxial support. The support conductor sizes were chosen to provide a characteristic impedence close to 50 ohms. In my unit I used a short length of RG-17/U coax with the insulation (both inner and outer) removed and with the ends of the shield braid tinned to help it hold its shape. If you use tubing for the outer conductor, drill a small hole near the end that mounts to the end of the can. This will keep the oil from being forced out the coax connector. The top end of the center conductor is drilled to accept the center stud of the coax fitting. The connector I used is a single hole mount UHF fitting. A screw mount fitting should work as well. The center of the lid of the can is drilled to accept the coax fitting.

Begin assembly by soldering the resistors

between the two discs. Next solder the coax fitting to the lid of the can. Solder the center conductor to the center stud of the fitting, being careful to keep the center conductor perpendicular to the plane of the lid. Solder the outer conductor to the lid after centering it around the coax fitting and making sure it is perpendicular. Slip the assembled resistors and discs in place and solder the upper disc to the outer conductor and the lower disc to the inner conductor. Fill the can to within about 1" of the top with oil.

Transformer oil is superior, but salad or motor oil will work. Put the lid on the can, give the outside a coat of flat black paint, and presto!

Results: I must say that the results were, at the least, quite gratifying. Some of you are probably wondering why no vent in the can for leaking oil as the Cantenna has. Well, a unit of this simplicity can't have everything! Seriously, I found that the load "breathes" through the coax fitting and there is no problem of pressure buildup. If you use a fitting which is sealed, a vent will be necessary. The VSWR of the unit measured as follows: 4 MHz, 1.05:1; 30 MHz, 1.05:1; 50 MHz, 1.05:1; 144 MHz, 1.08:1. The reactance at 44 MHz is capacitive. The unit was tested at 50 watts rf for thirty minutes. At the end of this period the can was not too warm to hold and the resistance of the element had drifted upward only 0.5 ohms. After operating at 50 watts for thirty minutes, the power input to the load was raised to 200 watts for five minutes. The can was still not too hot to hold and the resistance of the element had drifted upward only 1 ohm. I think you can see what I mean by "gratifying". It appears to me that the Quartenna should handle 50 watts continuously or 200 watts RMS or 400 watts PEP on an intermittant basis.



Suffering from cramped quarters or a flat pocketbook? Need a good dummy load? Then why not shell out about three bucks, a few feet of solder, a pleasant evening's work, and build yourself a Quartenna?

My thanks to WA6IHX for his help with the photography.

. . . WA60BH

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Hydronics or Radio?

In the May 1966 publishorial Wayne Green made brief mention of the reports from Sarasota, Florida on the probable existence of a new form of radiation termed, for want of an existing word, hydronics. Just a year later, in the May 1967 *Radio-Electronics,* an article appeared which described practical experiments in the new form of underwater communication. In the 1966 *Proceedings of the Joint Technical Advisory Committee* (IEEE/EIA) there are several references to hydronic radiations and a considerable amount of memoranda on the subject.

I do a lot of reading. For the benefit of those who do not, I thought it might be interesting to go over some of the arguments and add a few of my own. The people at Sarasota say that most of the conventional explanations of their results have been advanced by scientists who have not witnessed the full gamut of such demonstrations. I haven't seen *any* of their demonstrations, so the only thing that doesn't drop me right into the group of explainers is that I am not a scientist either. Fools step in. . .

But hams have uncovered things that scientists have overlooked, and real results are sometimes achieved from persistent serendipity (the process of talking and talking and talking about something until eventually a fundamental truth pops out that none of the talkers was aware of originally). So much for my unqualifications to discuss hydronics. If you aren't interested in my own observations, just ignore the paragraphs in italics.

What is it all about?

There must be somebody who hasn't heard of hydronics, so let's go over the basics briefly. It has been discovered that if a pair of special antennas are submerged in water several miles apart, an AM signal can be sent from one to the other. If the antennas are brought closer to the surface, the signal increases; if they are brought above the surface, the signal disappears or is greatly reduced. If one antenna is left below the surface, communication is possible with certain other types of antenna above the surface and at a distance. Communication can be achieved over a distance greater than that predicted by the normal electromagnetic radiation formula used to show the attenuation expected on an underwater path.

From this, the proponents of the "Hydronics Theory" deduce that there is a form of radiation from the transmitter somewhat different from electromagnetic radiation, possibly a form of energy heretofore not proven to exist, although hypothesized by some of the early experimenters in radio and electricity.

This becomes interesting to the JTAC subcommittees because the thought rears its ugly head that besides all the pollution of the radio spectrum by the emissions we already know about (No, not the VOA in the 7-MHz band!), there may be a whole slew of emissions using the same frequencies but of a different nature. Can't you just hear the groans of the landlubbers being echoed by resounding cheers from the naval types!

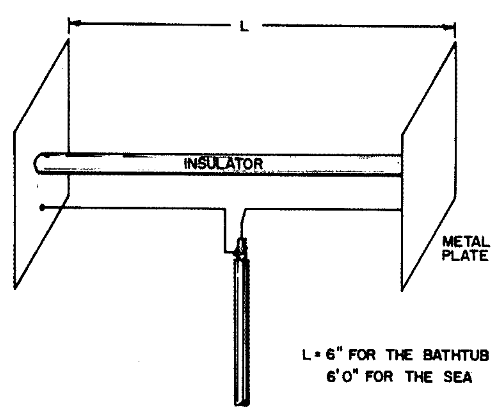


Fig. 1. Underwater dipole for studying the effects of underwater radio transmission. For bathtub experiments the dipole can be about 6 inches long; for ocean testing six feet is preferred.

Practical details

Typical antennas are short dipoles with flat plates at the ends, center fed with an insulated balanced feeder (see **Fig. 1**). For simple experiments in a bathtub, Jack Althouse's article[1] shows a simple one-transistor oscillator modulated by a one-transistor tone generator. There isn't any magic claimed for the gear, but it is easier to build something like that than it is to figure out a way to modulate your **VFO**!

Bathtub antennas can be any size you find convenient. The longer they are and the larger the endplates, the stronger will be the radiation. If you go whole hog and do it in the sea, try 6-foot dipoles with plates one foot square, and do it on 160 meters. If you use a full-scale transmitter you will need some walkie-talkies or something for "order-wire" because the transmissions will go a long way. Very low power and furious waving of arms or shouts works out to be more convenient in the long run. Go QRP.

No magic about the receiver either—anything that will receive on the frequency, detect the modulation, and couple to a dipole will work. If it isn't screened, you may have some perplexing results!

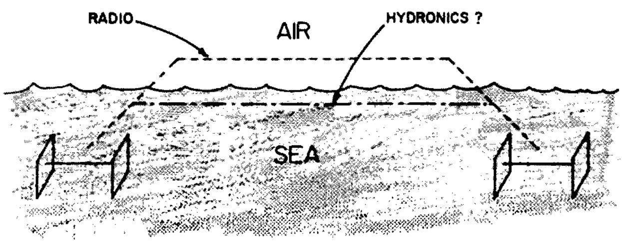


Fig. 2. Do the signals travel above or below the sea-air interface?

Experiment 1

Two antennas are immersed in the ocean, 100 meters apart. Each antenna is a 6-foot dipole with metal end plates. A signal transmitted from one antenna to the other is found to be maximum when the antennas are in line with each other, minimum when they are broadside, **Fig. 2**. Sarasota says, "With radio waves, maximum signals would be received when the transmitting and receiving antennas are broadside, and a minimum signal when they are coaxial."

Although everyone remembers that the maximum lobes of horizontally polarized waves are at right angles to the wire of a horizontal dipole, many people forget that the maximum vertically polarized waves are emitted from the ends, **Fig. 3**. *If you consider for a moment that this might be normal radio propagation, you will agree that horizontally polarized waves would not travel far across the surface of land or water before being attenuated by the short-circuiting effect of the horizontal surface. So, along the lines of, "if it's radio, it would have to be vertical polarization", we would expect the antennas to be end on to each other.*

Experiment 2

The receiving antenna is replaced by a single plate. The transmitting antenna is rotated and it is found that the signal is at a maximum when the transmitting antenna is end on. Communication ceases when either or both antennas are removed from the water.

Experiment 3

The antennas are exchanged end for end. The dipole shows the same directivity when used as a receiving antenna. Communication ceases when either or both antennas are removed from the water.

Let us assume that a radio emission has emerged from the water at a point close to the transmitting antenna and then travels along the surface as a vertically polarized wave. The receiving antenna, when removed from the water, would only respond to the wave if it has the capability of receiving signals from a horizontal angle. Although a horizontal dipole transmits or receives vertically polarized signals off the ends, this is almost all high angle radiation. This is one reason you work so well off the ends of your 40-meter and 80-meter horizontal dipole—it surprises many hams, but it shouldn't!

From the description of the experiment it seems that the single-plate antenna (termed a monopole) consists of a plate perpendicular to the water surface and fed by a single horizontal wire. It would be interesting to know whether a vertical stick monopole above the water would receive the signals that the vertical-plate-on-a-wire could not. See **Fig. 4.**

Experiment 4

Two monopole antennas are used. Both act omnidirectionally. Communication ceases

when either or both are removed from the water.

Experiment 5

A dipole antenna below the surface transmits to "an antenna" above the surface. Rotation of each shows maximum signal when they are collinear.

It is difficult to comment on this because it is not clear what kind of antenna is at the receiver. The same goes for **Experiment 6.**

Experiment 6

A sealed transmitter with 0.1 watt output to a two-meter-long dipole antenna is lowered into 30 meters of sea water. A vertically disposed dipole just below the surface is connected to a receiver. Measurements show that as vertical distance between the antennas is varied, the attenuation varies as the square of the distance. Similar experiments in a horizontal plane, with the antennas end on, give the same results at the same distance.

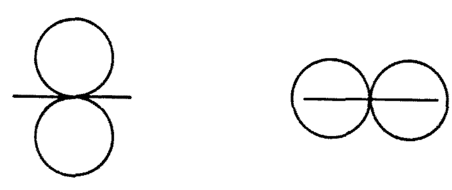
This only shows that if the signal travels through the water all the way, water has the same conductivity in one direction as in another. If we consider the signal emerges from the water, travels horizontally across the surface of the water in the air, and returns part of its energy to the water continuously as it travels along, then **Experiment 7** *is not of much interest, as it only proves what we already know—that water is a rather poor medium for the internal propagation of radio waves.*

Sarasota says, "The attenuation of a 6-kHz radio signal after traversing 100 meters of sea water is about 250 dB. To receive a signal over that distance on a receiver with a sensitivity of 10^{-9} watts would require a transmitter power of 10^{61} watts . . . Since the power required to transmit a radio signal under these conditions is so great, it is unthinkable to ascribe these phenomena to conventional radio waves."

But what if the signal goes a few meters through the water, best part of 100 meters through the air, and then into the antenna through another short water path? There is plenty of literature supporting the theory that if a radio signal passes through an interface between two media of radically different density, the signal will be refracted along the surface of the interface. Staiman and Tamir[2] say that the only necessary condition is that the signal must arrive at the interface at the critical angle. As the signal travels along the surface of the sea, in the air, it constantly returns a portion of its power to the sea, entering the surface and propagating downward at the same critical angle. It will be intercepted by a receiving antenna below the surface.

If you have forgotten your high school physics, fill a glass with water and hold a knife blade in the water, entering at an angle of 45° or so. View the blade from various angles looking down into the water, and the knife will appear to be bent. This is optical refraction. If you have ever tried to spear a fish from a boat you will already have learned about this the hard way!

So now we have a possible explanation for the underwater communication. The heavily end-loaded horizontal dipole radiates vertically polarized waves off the ends towards the surface of the sea at such an angle that when the wave emerges from the surface it is refracted to the horizontal. It then propagates over the surface of the sea. The attenuation over the main portion of the path is that of a surface wave in air over a good conducting layer. All the way along the over-water path, part of the energy of the wave front is fed down into the water, entering the water at the same critical angle which gave rise to the propagation of the wave. Staiman and Tamir go into an extensive dissertation on the features of the lateral-wave component of the surface wave. This gets a bit deep even for those hams not unhappy about the provisions of the new incentive licensing law.



(a) (b)

Fig. 3. The directional pattern of a short horizontal dipole is shown in A (horizontally polarized waves). Directional pattern of a short horizontal dipole showing the high-angle vertically polarized waves.

So What?

So what conclusions can we draw from this? Anyone who sticks out his neck by drawing positive conclusions has courage. But at least there is good reason to believe

that the scientific world will continue to be skeptical about the existence of a new form of energy until considerably more detail has been published of controlled tests.

It would be very interesting to make some tests on UHF or microwave over a very short path and see what happens when a metal plate is suspended first in the air and then in the water at the mid-point of the path—or is that too simple a way to determine where the wave is travelling?

Signals from fish

Sarasota Research & Development also reports some very interesting experiments with fish. One hundred thirty species have been studied, and they all emit signals receivable on an electronic receiver. Each kind of fish can be identified from the character of the signal. For example, sea robins transmit short pulses at 170 Hz, black drum transmit on a carrier frequency of 6.5 kHz, and pinfish on 28 kHz.

The part of the fish said to give rise to the omissions is the skin surface along the lateral line. The skin transmits a signal even after having been separated from the rest of the body, and radiations have been monitored 100 meters away from the fish.

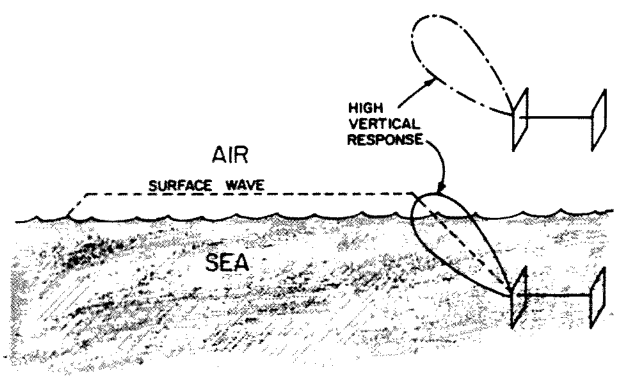


Fig. 4. An antenna with maximum response at a high angle might work fine under the water, but pretty poorly above it.

Who needs transmitters?

Another interesting report is, that using a dipole with end plates of dissimilar metals immersed in sea water, radiations are emitted from the antenna even when no transmitter is attached! Yet a VTVM with an input impedance of 10^{14} ohms connected across the feed point of the dipole shows no potential gradient to exist. One of the plates was of zinc and the other of copper, and the signal was receivable 100 meters away.

So there you are. Undoubtedly there are some very interesting things going on in Florida, and before long there may be some new electronic aids for fisherman, and for divers. Whether it be hydronics, plasmonics, or just plain old radio, the search for better communication goes on. And, I guess, so will the argument.

. . . VE7BS

References

1. J. Althouse, "Build Hydronic-Radiation Transmitter," *Radio-Electronics*, May 1967, page 37.

2. Staiman and Tamir, "Nature and Optimization of the Ground (Lateral) Wave Excited by Submerged Antennas," *Proceedings of IEEE*, Volume 113, Number 8, August 1966.

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Electronic Temperature Measurements

Frequently in electronic work it is necessary to determine the temperature rise of components located in areas that are inaccessible. When use of a thermometer is inconvenient or impracticable, in industry we generally turn to thermocouples and potentiometric recorders. Alternately, thermistors can be used, if the curve of resistance vs. temperature is available. These can be purchased for around $5.00 from Allied Radio. An accurate meter to measure the thermistor is to be desired.

For the single shot type of temperature measurements the average amateur is likely to encounter, such as determining the temperature rise of a TV transformer used in a home-built transmitter, or the temperature rise in the compartment of a VFO where installation of a temperature compensating capacitor is contemplated, there is a far less expensive method. This involves very simple calculations based on the change in resistance of copper wire as its temperature is raised. Since these are relative resistance measurements absolute accuracy is not required. The percentage change is the important criterion. Hence an ordinary ohmmeter can be used providing it gives repeatable readings and is used on a scale where changes of 20 to 50 percent can be readily recognized.

Let's take the transformer discussion first. Ordinary type commercial transformers use Class A insulation and should be limited to about 212° Fahrenheit or 100° Celsius (formerly called Centigrade). The ambient or room temperature plus the temperature rise should not exceed this value. In case you've forgotten, to go from degrees F to degrees C, simply subtract 32 then divide by 1.8 (or multiply by 5/9 if it seems easier). Now then, copper which has been annealed, like soft drawn magnet or transformer wire, has a temperature coefficient of resistivity of 0.00393, so each ohm of it will increase 0.00393 ohms for each degree C of temperature rise. This isn't perfectly linear of course, but is accurate enough for all practical purposes. By juggling a few figures, or checking a reference book, we find that the temperature *rise* of the transformer winding will be:

$$T = 255 \left(\frac{\text{R hot}}{\text{R cold}} - 1 \right) {}^\circ\text{C}$$

So, the procedure is to simply measure the tranformer primary resistance when it is cold, watching out for parallel circuits that might cause false readings. Then operate as usual for the maximum expected time. If you use CW, don't lock the key down. Then, at the end of the session, again measure the primary and calculate the temperature rise. Add this to the room temperature. This tells you the temperature inside the transformer, where it counts.

It may be of course, that some will insist on more accurate measurements, since the transformer did cool down somewhat between the time power was disconnected and you got around to checking it. Lets say it took one minute. Then at one minute intervals take several more readings. Draw a simple graph and plot it back to time T = O. This gives the actual hot resistance. The graph will be nearly linear and a smooth curve easy to plot.

To calculate the required temperature compensating capacitor to use in parallel with the tuning capacitor to compensate for drift; we must find the temperature rise in the area of the enclosure where the TC is to be located. A simple sliderule is available for only 18 cents to perform the calculations. (Allied 19U916). To find the temperature rise, suspend a tiny transistor interstage transformer in the VFO. Don't let it touch the chassis. A tiny one should be used to insure that it will have a short thermal time constant. This is necessary if we want to follow the changes in the air temperature. As with the power transformer, measure the coil resistance when it is cold, and as the equipment goes through its warm-up cycle. Then calculate the temperature rise as indicated for the power

transformer. An important difference; *do not* add the room temperature. The °C rise is all that is required for calculating the change in capacity of a TC capacitor. If you don't feel like spending the 18 cents for the calculator, you can always figure that for small changes in capacity, the frequency shift is nearly linear, and work it out from there.

Since two other methods of temperature measurement were also mentioned as a teaser, a brief discussion of them might be in order. Allied Radio has, in their Industrial Catalog, a one percent accuracy thermistor, with curve, for about 5 dollars. Or, in their wishbook for Everyone, they have a kit of 4 glass beads (thermistors), probes, manual, and curve computer for the same price. Discs are less than a dollar, but you calibrate them yourself.

In using thermistors at least two precautions are necessary. First of all the measuring instrument must not supply appreciable power to the thermistor, or else self-heating effects will nullify the calibration. Second, with beads, remember they have a very short time constant, the same as many other semiconductors. In other words, they blow out faster than they can be disconnected. And, as was mentioned, the tiny ones can get lost when you suddenly sneeze. See: *Which Way is UP?*. 73-Feb. '62.

While thermocouples are widely used and simple to make, they have one great big disadvantage. The output is in the order of millivolts and the lead resistance is high. Hence, unless a very sensitive meter is used, the meter and thermocouple must be closely matched. Clip the leads short and the accuracy is gone. If a sensitive millivoltmeter is available, a conversion chart can be readily obtained which will give accurate temperature readings. This permits making several simultaneous measurements in a chassis by switching in numerous thermocouples. Leeds & Northrup Co. (see the yellow pages) has a conversion table booklet at a very nominal price, like free. That is, if you can convince the person who answers the phone that you do a lot of such work. These conversion tables are generally based on using a reference thermocouple at 32° F or 0°C. This requires icy slush, and can get messy. Of course the chipped ice can be used for cooling other stuff which may help pass the time during the temperature run.

With a small VFO, you may be able to sneak it into your place of employment, or have a good friend take it in and check it for you, doing the measurements with professional equipment. Most industrial electronic and chemical plants make considerable use of temperature measurements obtained by thermocouples and recorded or indicated on potentiometric recorders. The recorder is generally a bridge circuit which is balanced by a servo mechanism driven by the error signal from the bridge. At balance, the voltage from the thermocouple is matched by an equal but opposite voltage from the recorder. The net result is an apparently infinite input impedance, so the thermocouple is not loaded and the length and resistance of the leads is of no consequence. This isn't really true of course, since at balance we wouldn't know if the reading is steady or the recorder dead. A little jitter is generally added to make things look alive. Far off balance the recorder input impedance may be IK ohms or less. But the readings there are, of course, unimportant. Of importance is the fact that up to 12 automatically switched inputs may be available, allowing one to locate thermocouples all over the VFO chassis to find the hot spots. And a continuous recording helps to tell what causes the frequency to drift back and forth. No ice bath is required in most set-ups since automatic temperature compensation is generally included.

Other temperature sensing elements, such as diodes and transistors are available. For simplicity, the copper resistance method is hard to beat. For economy, it *can not* be beat.

...K6EAW

Propagation Chart

FEBRUARY 1968

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7B	14	21	21A	21
ARGENTINA	21	14	14	7A	7	7	14A	21A	21A	21A	28	28
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	14A	21A	28	28	28	21A
ENGLAND	7	7	7	7	7	7B	14	21A	21A	21	14	14
HAWAII	21	14	7B	7	7	7	7	7B	14	21A	21A	21A
INDIA	7	7	7B	7B	7B	7B	14	21	14	7B	7B	7
JAPAN	14	14	14B	7B	7B	7	7	7	7B	7B	7B	14
MEXICO	21	14	7	7	7	7	7	14A	21A	21A	21A	21
PHILIPPINES	14	14	14B	7B	7B	7B	7B	14	14	14B	7B	14B
PUERTO RICO	14	7	7	7	7	7	14	21A	21A	21A	21	14
SOUTH AFRICA	14	14B	7	7B	7B	14	21A	28	28	28	21A	21
U. S. S. R.	7	7	7	7	7	7B	14	21A	21	14	7B	7B
WEST COAST	21	14	7	7	7	7	7	14	21A	21A	28	21A

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	14	21	21A	21A
ARGENTINA	21	14	14	7	7	7	14	21A	21A	21A	28	28
AUSTRALIA	28	21	14	7B	7B	7B	7B	14	14	14	21	21A
CANAL ZONE	21	14	7	7	7	7	14	21A	28	28	28	28
ENGLAND	7	7	7	7	7	7	14	21	21A	21	14	7B
HAWAII	21A	21	14	7	7	7	7	7	14	21	28	21A
INDIA	14B	14	7A	7B	7B	7B	7B	14	14	14B	14B	14
JAPAN	21A	14	14B	7B	7	7	7	7	7	7B	14B	21
MEXICO	14	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14B	7B	7B	7B	7B	14B	14	14	7B	14
PUERTO RICO	21	14	7	7	7	7	14	21A	21A	21A	21A	21
SOUTH AFRICA	14	14	14B	14B	7B	7B	14A	21A	21A	21A	21	21
U. S. S. R.	7	7	7	7	7	7B	14B	14A	14	14	7B	7B

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	21	14	7	7	7	7	7	14	41	21A	21A
ARGENTINA	21A	21	14	14	14	7	7	14	21A	21A	21A	28
AUSTRALIA	28	28	21A	14	14	7	7	7	14	14	21	21A
CANAL ZONE	28	21	14	7	7	7	7	14	21A	28	28	28
ENGLAND	7B	7	7	7	7	7	7B	7B	14A	21	14	7B
HAWAII	28	28	21	14	7A	7	7	7	14	21A	28	28
INDIA	14	21	14	7B	7B	7B	7B	7B	14	14B	14B	14B
JAPAN	28	21	14	7A	7	7	7	7	7	7B	14B	21
MEXICO	21	14	7	7	7	7	7	7A	21A	21	21	21
PHILIPPINES	21A	21A	14	14B	7B	7B	7B	7	7	14B	7B	14
PUERTO RICO	21A	14	14	7A	7A	7	7	14A	21A	28	28	28
SOUTH AFRICA	14	14	7	7B	7B	7B	7B	14	21	21A	21A	21
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14	14B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21A	21A	28	21A

A - Next higher frequency may be useful.
B - Difficult circuit this period.

Good: 1, 2, 7-11, 13, 14, 16-18, 25, 26, 28, 29

Fair: 3, 4, 6, 12, 15, 19, 20, 22, 24, 27

Poor: 5, 21, 23

VHF: 2, 3, 9-11, 13, 27, 28, 29

(*WIEMV from pg.* 2)

ones. We have broadcasts of music, hate messages designed to create racial riot, obscene language, and wild drunken parties. The assumption is that these are amateur operators who don't care about their tickets anymore. But, assuming that they are intruders who have taken this means to give amateur radio a black eye, we still have a long way to go to clean house.

We keep talking about the problem of attracting new hams. The idea being that the more hams we have, the better our chances will be of keeping our share of the radio spectrum when (and if) there is another frequency allocations conference. However, our choice of newcomers should not be indiscriminate. Before you "sell" our hobby to a casual acquaintance, look at him with an objective eye. Is he (or she) a normally courteous person? Is he the kind of person you would like to work side-by-side with on the same band? If not, don't encourage him to join the hobby. From a psychological view, there are some people who will use ham radio to make like a "big shot", and no amount of incentive legislation will change a basic personality defect. Let's attract the people who will be an asset to the hobby and fight to keep the others out.

Many of our readers have expressed the opinion that the amateur exam (even the General) is too hard. The code should be eliminated so they could pass the exam, etc. I began working for the General license when my kids were still young and required lots of my time. I set a goal for myself to go from knowing nothing about code or theory to the General in a period of four months. I made it, but it was hard work under trying circumstances. I think my license means more to me because I had to work for it. I don't want to see the requirements lowered. This would only bring in more people to whom the hobby is simply a lark and the license unimportant.

. . . WIEMV

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

(W2NSD from page 5)

to New Hampshire and set about getting the subscriptions straightened out from the foul-up created by a subscription agency that had been handling them for us.

The shortage of money kept us from hiring anything but drop-outs, with the result that few things were ever done right and the letters of complaint generally were about equal to the subscriptions. The rich get richer and the poor get poorer. When these problems did seem to be ebbing I immediately bit off another big bite to chew . . . Radio Bookshop never made money, but it was, I felt, a valuable service. 6-UP lost a bundle for us. As did the parts kits and ATV Experimenter. But we were providing a service, so I kept them going.

Eventually, as usually happens to fellows who are totally immersed in their work, I found my wife fed up and divorcing me. I reacted about the same as everyone else who has been through that misery . . . I went into apathy. I could no longer work. Paul Franson, who had been our bookkeeper, took over as editor. All of the services depended heavily on me and they had to go. I stopped trying to sell advertising and our ad sales dropped off badly. The great bulk of the advertising during this time was unsolicited.

In order to try to break out of my depression I made a couple of trips to Europe, my safari to Africa and trip around the world. Unfortunately the management of the magazine was left in very weak hands and when I got back from my trip I found that the magazine had dropped a month behind. My safari and trip around the world cost about $3500, but in the meanwhile the magazine had lost about $25,000 and was in a sick condition.

I set right to work solving the problems again. My apathy was solved by the simple expedient of finding a fabulous girl and getting married again. I solved the late magazine problem by moving to a new printer that could get us out on time. This is a complicated and expensive procedure. Circulation problems were still bugging us and I decided to make the big changeover to a computer for the subscriptions. We're still getting a lot of QRM from irate subscribers who have been ill-treated by the new computer, but I hope that we will eventually get it tamed and be able to provide the best subscription service of all.

I'm working on the advertising again, so I hope that we will be pulling ahead a little more in the number of ads in 73. The ads, as I have mentioned often before, are the things that pay for your magazine, so don't look your gift horse in the mouth. Be nice to our advertisers, patronize them, encourage them.

Kayla has taken over as editor and I think we will all be seeing the difference. You may find some of her opinions controversial, but you won't find her writing boring and pedantic. Her interest in building should result in a lot more coverage of construction projects and VHF developments. She has some wonderful ideas for improving the magazine.

It was too bad that I had to give up the Radio Bookshop. While this activity never made us enough money to even think about, it did provide a good service to our readers and made radio books easily available. This took a lot of my time. I had to check into all new books published to find those that would be of value to hams. Then, when I found them, I had to order them, make sure they were delivered, pay for them, write up ads to run in 73 for them, make sure that orders were filled, keep the books straight, and keep after publishers to fill our orders. There was a lot of correspondence with customers who couldn't understand why we would advertise a book and then not deliver for a month or so after his order. I would have to explain that the publisher had promised delivery, but hadn't made good yet. It took an awful lot of my time so it had to go when I found myself unable to work more than a few hours a day.

The parts kits were another giant headache. The idea of the project was to make kits of parts available for various 73 construction articles so that the ham with the weak junk box could get in on the fun of building without having to order parts from a dozen different sources. We thought that since few distributors were trying to sell parts that there would be little trouble from them, but we reckoned without the help of CQ. They got right to work and wrote letters to all the distributors screaming that we were trying to put them all out of business. A few of the more hysterical distributors believed CQ, but most realized that our project would hurt no one and, to the contrary, might just encourage more

hams to get in on the fun of building and that everyone might be the winner in the long run.

The parts kits took a tremendous amount of my time. I had to make sure that all the parts were on hand and put the parts into the kits for each one. I had to get boxes, write and print instructions, keep the records, pay the parts bills, etc. Such aggravation. It was nice to stop all that.

One more year of red ink just might sink us, so I've been encouraging a cut back in our staff. Paul went down with Davco. Jack has retired. And Jim is busy trying to start his own ham magazine. I gather that he has been working with a wealthy New Hampshire ham for almost a year now on the plans. With our reduced staff of four paid employees I think we will be able to get 73 back into the black and even be able to keep our subscription rates as their present level for some time to come. I notice that CQ is raising their rates.

I'm back on my sixteen hour work days again. I don't know how long Lin will put up with it, so I hope that we can get enough advertising and subscriptions so I can occasionally take a day off for some skiing or a dinner out with her. I had hoped to be able to take her to Europe, paying for the trip by running a tour next spring, but I can see now that there really is no way that I can get away from the magazine for the three weeks required while I am handling the advertising and publishing. It is very disappointing to have to give up our plans for the trip, but it will take longer than spring before we are back on solid financial ground.

Perhaps the apathy over my own problems explains the lack of aggressiveness for the last couple of years in 73. It must be that because things certainly have not been going well in our hobby. Incentive licensing has done a lot to change ham radio. CB has had an effect too. There are probably a lot of other factors which have acted to reduce interest in ham radio and to cut down the sales of equipment and parts to hams. I don't think there is much purpose in bearding the villain. It seems to me that we should now get started at meeting our world as it is and stop grumbling about how it is or who made it that way.

The bulk of us are having to face the

reality that if we are going to continue to enjoy all of the ham frequencies we are going to have to go down to the FCC and pass a new and tougher examination. During the next year I would like to publish a lot of good basic theory articles which, taken together, will make it possible for all of us to pass these new tests. This is a good opportunity for those of you who have done some teaching and who would like to do some writing to put together some articles for us. I want to see simple and complete explanations which will give us the understanding to handle the new exams. How about it?

Another thing I'd like to see is some more humorous articles. There is no shortage of foibles in ham radio to be kidded. If you enjoy writing a good humor story you might turn your talent to any of the major ham interests . . . traffic handling . . . mountain topping . . . VHF pioneers in empty bands . . . the lonliness of the moonbounce operator . . . DX contests . . . DXpeditions, unless Miller has killed them for everyone . . . I see that Miller has found a publisher for his DX book. I looked over his outline, decided it was a hodgepodge, and wrote my own book which, with luck, will be out by the time this is printed. Articles . . . the 75M DX crowd . . . the 160M DX addicts . . . the poor souls who are stuck high up on the ARRL Honor Roll . . . the mobile DXer . . . the CW mobileer . . . etc. All you have to do is listen in on any band for a few hours and the articles will write themselves. We'll print them if I laugh.

If you don't mind too much we'll let the other ham magazines stick to being serious. Our hobby may be a service in the eyes of the ARRL, but to me and a lot of others it is enjoyable . . . it is fun. I suspect that as soon as amateur radio stops being fun it is going to fold up, so let's stress the fun side of our hobby. It is fun to build . . . it is fun to operate . . . it is fun to do unusual things. Let's see what we can do to make as much of amateur radio fun as we can. I always remember a fellow TV director who explained that he used to go in for boxing, then one day he found himself being beaten to a pulp in the ring. He suddenly discovered that he wasn't having any fun and that was the last time he ever fought.

You can make ham radio fun for others by keeping in good spirits on the air and refusing to let illigitimate sons wear you down. You can make publishing 73 fun for me by putting up with our bumbling here and encouraging other amateurs to read the magazine. I'll do everything I can for you and I'll try to let you know what is actually going on in our hobby, good and bad.

Merchant Marine

There is a great shortage of shipboard ops these days. I thought this might be of interest to some of you younger fellows who are looking for a way to make ham radio pay off for you. You could do worse than check into the requirements and the draft avoiding possibilities. The money is rather nice too, running about $600 to $800 a month and most of that in the clear.

Burma

Editorially I am still wandering around the back reaches of Asia. In truth I am sitting comfortably back in New Hampshire waiting for the heavy snows to bring the skiing season to northern New England. The whole trip, including the safari hunt in Africa of two weeks, only lasted about twelve weeks.

I might have skipped Burma if they hadn't tried so hard to keep me from coming. I'm that way, as you probably know if you've been reading 73 for any length of time. By tenacity and amazing luck I managed to find myself deplaning last September at Rangoon airport late one afternoon. My visa for Burma was by far the most difficult to get; requiring days of waiting on the Burma Mission to the U.N. in New York. I had no idea what lay ahead since, as far as I could find out, nothing had been written in any of the popular or travel magazines or books about Burma since the army coup five years ago. The amateurs had been put off the air at the time, so I had no personal contacts to follow up as I had in most other countries.

There were just three of us on the entire plane flying from Calcutta to Rangoon and the other two were obviously Burmese government officials. They were met by cars at the airport, leaving me to run the gauntlet of customs and immigration alone.

The first step was to fill out a currency declaration listing every bit of money that I

had with me. They check this when you leave the country to make sure that you haven't exchanged any foreign currency at other than the official exchanges. You have to have a receipt for every dollar exchanged. The reason for this is that they have a very serious inflation there and the world exchange rate is about 15 kyats to the dollar, while the official rate is under 5 to the dollar. This means, practically speaking, that everything costs you about three times normal.

Then, while the customs men were examining my baggage, I signed into the log book for entering the country. I looked back through a few pages to see if any other Americans had visited recently, but could only find entries for U.S.S.R. and the People's Republic of China for the last few weeks. Apparently I was the only American to visit Burma in quite a long time.

A small bus drove me from the airport about twenty miles to downtown Rangoon and the Strand Hotel. My room was $12 a night, but it was a large room with air conditioning and a bath. This was over three times the price of the same accommodation in India. It was about dark when we got to town so I didn't get a chance to see very much.

My first move was to try to locate a local amateur that I'd heard about from the amateurs in India, but he wasn't listed in the phone book. I asked the hotel manager about Miller's visit there the year previously. He said that he had no record of a Miller visiting and was sure that no radio amateurs had either visited or been permitted to operate from his hotel. I didn't know what to make of this for Don had claimed to have been there.

After dinner I decided to make a major try to locate the local ham. I asked the bellhop to get a taxi for me and, after quite a wait, he arrived with a fellow on a bicycle with a small side seat fastened on. I gave him the address and he said he knew right where it was. Well, we drove around the back streets of Rangoon for about an hour, with him asking people where the street was we were looking for. Finally we found it; an old shabby building, all black. It looked deserted. The whole neighborhood looked deserted. I knocked.

There was a long silence, then the door opened just a crack. I quickly shoved in a QSL card. The door was flung wide open; "Come on in, I'll get my father, sit down." The

whole family gathered around and explained what had happened to Burma and amateur radio in their country.

Rangoon used to be a paradise. It had a large middle class population and was one of the fastest growing and most advanced cities in southeast Asia. The people owned and ran the businesses . . . they had beautiful homes and nice summer places, clubs, restaurants. Then, about five years, ago, the army overthrew the government and everything changed. First they took over all of the banks and confiscated the bank accounts. Next they issued new currency to be sure that no one had any savings in cash put aside for the future. The largest denomination of the new currency was about equal to a dollar (five kyats). This made it so that even if someone was able to gather a good deal of money it would be so bulky that he would have a very difficult time carrying it around.

The new government then proceeded to take over every business in the country, large and small, excepting only small family run restaurants. They gave no compensation for this takeover. They put the pressure on all foreigners living in the country to get out as soon as possible, cutting off all possible income, food supplies, clothes, and even visiting friends. They harassed them and most of them left, including people who had devoted their life to working and living in Burma. Most of the businesses appropriated by the government simply closed. All amateur radio priviledges were suspended.

Schools, hospitals and all other such organizations were taken over and the bulk of the staffs dismissed or changed. Clubs and restaurants were taken and closed. Every business that is running today, large or small, is owned and run by the government. All automobiles were confiscated. Machinery of any value was removed from all companies that closed down.

This has been very hard on the people. They were used to a relatively high standard of living, now, with everything at a virtual standstill, the smallest item is rationed and government red tape stands between you and any purchase. Prices are astronomical. Just about all trading is done via small suitcases in the rapidly moving black markets. For instance soap is rationed one bar to a family per month. . . one suit of clothes per year. If someone is fortunate enough to have

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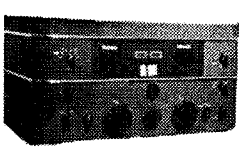

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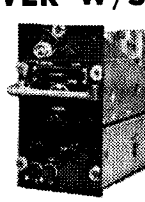

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FAIR RADIO SALES

DEPT. 73 — P. O. Box 1105 — LIMA, OHIO 45802

WANTED: July 1962, July and August 1966 issues of 73 Magazine. WA1GHW, Rt. 1, Box 571, Terry Rd., Gales Ferry, Conn. 06335.

MECHANICAL ELECTRONIC DEVICES CATALOG 10¢ . . . Teletype Model 14 reperforator with automatic tape take up rewinder 115VAC60cy. Both units new, unused $69.95 . . . ARR27 Receiver 29 tubes 465-510 MHz w/60 MHz if new, unused $35 . . . 1/16 laminated copper clad 2 oz. 2 sides, for printed circuits 9½x4½ $1 . . . 3/$2. Transistor boards bonzana $5.95 . . . Wide band balanced modulator $4.95 . . . 30 MHz IF Assembly $5.95 . . . Transmitter TDG w/Modulator easily converted to 2 meters $49.95 . . . Low pass filter 0-32 MHz 52 ohm $9.95 . . . 5KV/2KV/1KV at 750 ma/200ma/250ma Power supply write for details. Fertik's, 5249 "D", Phila., Pa. 19120.

TOROIDS, uncased 44 or 88 mH, also individually epoxy encased 88 mH for standards, any 5 $1.50, 255A relay $2.10, 18B socket 70¢ all PP USA. E. W. Evans K4OEN, 220 Mimosa Lane, Paducah, Ky. 42001.

FOR SALE. Ranger $60., SX110 $89, ARC-3, two meter Xmtr $20. wanted FM equipment. WA5FFK 804 So. 6th, Blackwell, Okla. 74631.

GONSET 2 METER SIDEWINDER: CW-AM-SSB, complete with AC & DC power supplies. Recently factory aligned. $230. K7DGV John Stiles, Sweetgrass, Mont. 59484.

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SELLING: HQ-145C, $150; Valiant, $140; BC-221 frequency meter, $50; C.E.-20A plus VFO, $100; HT-37, $200; Wanted: Drake DC-3. K9FWF/9, 114 North Orchard, Madison, Wisconsin.

FCC 1ST CLASS RADIOTELEPHONE LICENSE COURSE. Current, used, complete including radar ind. 70 lessons $60. W6UPZ, 508 Grape St., El Cajon, Calif. 92021.

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ROCHESTER, N.Y. headquarters again for the big Western New York Hamfest and VHF Conference Saturday, May 11.

HALLICRAFTERS SR-42A new, never used, original carton, matching HA-26 VFO, Shure 404c Mike—$200.00. Jeff Ross 125-12 Cronston Avenue, Rockaway Park, N.Y. 11694.

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★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

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SWAN 350 with 117Xc Power Supply $375. Heathkit Seneca Six-Two transmitter with external VFO $125. Stephens, W2NTZ, 3048 Wilson Ave., Bronx, New York 10469.

SUPER SALE, Micro Switch 10A 250V—99¢, 5894—$9, 6883 (6146)—$2, 2C39—$3, 416B—$5, 4X150—$5, 4-400—$19, 833—$19, 3CX10,000—$39, 4-125—$14, 6155—$14, 7378—$19, 5867—$19, 3X3000—$19, 3WP1—$9, 6166—$49, 7038—$29, Eimac SK300 Socket—$19, SK712 Socket—$9, Vac. Var. Condensers—$19, 5 Ft. dish—$49, Dual Xtal Ovens—$1, 50-0-50$\mu$a Meter—$3, Incrm. Osc. Units, 10Xtals 10 to 11 Mc., Toroid Step Relay, Switch, Etc. Beautys, $3, Sola Regulat. Xformers 120PRI, 350 Sec.—$4, 5% resistors, any value 5¢, Daven Pads—$4, WA8GFR, 1423 West 52nd., Cleveland, Ohio 44102.

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WANTED—Will pay good price for clean unmodified SX-115 Receiver. Albert Horn WA2WMQ, 1135 Glenwood Rd., Toms River, N.J. 08753, Phone 201-341-9286.

TRADE HQ-110 for Johnson KW Matchbox, table top linear, or SB610 Monitor Scope, Tom Thurman Jr., Rt. 5, Sparta, Tenn.

NATIONAL NC303, 6 meter converter, XCU-27 calibrator, mint condition, $275. Utica 650 Six meter transceiver, VFO, mike, $130. Richard Ravich, 10 Coolidge Road, Marblehead, Mass. 01945.

WANTED broadband coil also crystal for 100v for 160 meters. WA6WXJ, Charles Harper, 131 Hillcrest Drive, Daly City, California 94014.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB P. Wandelt, RD #1, Unadilla, New York 13849.

COLLINS 32V3 Very good condition $150.00, manual included, extra 4D32 final $10.00, WB2GPR Bill Donson, 5 Division St., Binghamton, New York 13905.

REGULATED POWER SUPPLY. 225v @ 550 ma.-115v @ 100 ma. 4/6.3v @ 12a. Fully metered. 19 inch rack panel. 150 lb. $39.95. Write, Electronics Surplus Co., P.O. Box 1225, Boston, Mass. 02104.

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WANTED—Gonset 2 meter linear, II or III, must be mint—cash. Sale or Trade: NC-303 Cal. spk & manual mint—$275. SP-600 RX in cabinet $300. J. Gysan W1VYB, 53 Lothrop St., Beverly, Mass. 01915.

SWAN 350 with VOX and Calibrator, Mike. Excellent condition, no modifications, like new $300. K1EJW—Roland, Lowell, Mass. 458-1892.

AUCTIONFEST — B.A.R.C. — February 17th. Bargains unlimited. Location—Chaminade High School, 500 North 51st Ave., Hollywood, Florida. Doors open 8:00 AM, auction starts 9:00 AM. Free Coffee.

THE NORTH JERSEY DX ASSOCIATION is sponsoring its annual DX Round-Up on Saturday, March 23, 1968. This is the Saturday following the IEEE Convention in New York and it is expected that many out-of-towners will find it convenient to attend. Site of the Round-Up is the Holiday Inn, Wayne, N.J. at the intersection of Route 46 and Route 23, just 30 minutes west of the George Washington Bridge. The afternoon program starts at 2 P.M. and banquet at 7 P.M. Further details available from W2PXR.

COLLINS SSB STATION: KWS-1 Ser 1246, 75A4 Ser 4950, SC101 Station Control, Bandpass filter and table top. Will deliver to 400 miles., lot $900.00. Also Swan 350, 117X power supply, 14X DC module and mobile cables. Little used, $400.00 FOB W4CNC Vernon A. Sanders, 3105 Dyas Dr. NW., Huntsville, Ala. 35810.

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100 EPOXY DIODES 1.2 amps, 1000PIV $20.00. 800 PIV $18.00. 600 PIV $14.00. See page 96 Dec. 73. Check with order. Postage Paid. Pete Fragale W8AEN, Box 585, Clarksburg, W. Va. 26301.

COLLINS 62S-1 like new $600.00 or best offer. Will trade on Collins 30S-1 KW Amp. W4LZP, 327 Chamberlain St., Nashville, Tenn. 37209.

LATE MODEL SWAN 350 w/AC p/s $300.00. Will accept Delta or equal wood lathe, jointer or shaper in trade. John E. Bagwell, Somerville, Tennessee 38068.

Waterproof Connections

Just a hint for anyone who needs a permanent type of seal for wire splices and connections which are to be exposed to the weather.

A liquid plastic called "Plasti-Goop" is on the market for kids toys. It is distributed by Mattel for "Thing Makers" and other toys. The plastic liquid can be applied directly to the connection, or whatever one wishes to be sealed, then it must be heated to about 300 degrees for a few minutes to cure it. The Plasti-Goop is not flamable, and may be heated with a propane torch or over a gas burner for curing. Plastic coated wires, such as twin-lead, must be treated with care not to melt the insulation.

Two or three layers are needed to make a good seal and insulator. This has been used to good success here, especially on rubber covered wires. If you have a circuit which must be exposed to the weather and need not be disassembled or adjusted, the entire circuit can be filled and baked in an oven to cure at about 200 degrees. The plugs on the end of extension cords are a good place for this. It makes a neat, waterproof, and electrically sound connection. . . . James L. Townsend K9BXG

New Books from Sams

ABC's of Radio and TV Broadcasting, by Farl J. Waters, tells what is involved when you turn on a radio or TV set in terms a layman can understand. It describes how the radio and television signals are formed, built up, and transmitted and presents a basic survey of transmitter equipment and operation.

Mathmatics has been avoided and the material is easy to read and understand. Many illustrations are used to make the information completely clear. Catalog No. 20575 List Price $2.25.

FET Circuits, by Rufus P. Turner, starts with the principles of FET operation and describes their construction, but stresses the application of FETs in practical circuits. It discusses oscillator and amplifier circuits and presents examples of these circuits for use in receivers, transmitters, and accessory equipment. Various test instruments which can use FETs are also covered. Catalog No. 20585 List Price $3.25.

Dear 73,

The following equipment was stolen from me during Thanksgiving week: HQ120 and large speaker. Numbers and dates marked beside each tube socket; HQ140 and defective speaker (both gray) most knobs have white indicater marks added; KLH-8 FM radio and matching speaker in wood cases; Triplett #630 VOM; RDO Shack—small tube tester; Zenith "Long Distance 66" transistor portable radio (black); and Bausch and Lomb 20X Black target spotting scope. Notify Police Detective Bureau, Weymouth, Mass.

Art Bates W1RY
Hingham, Massachusetts

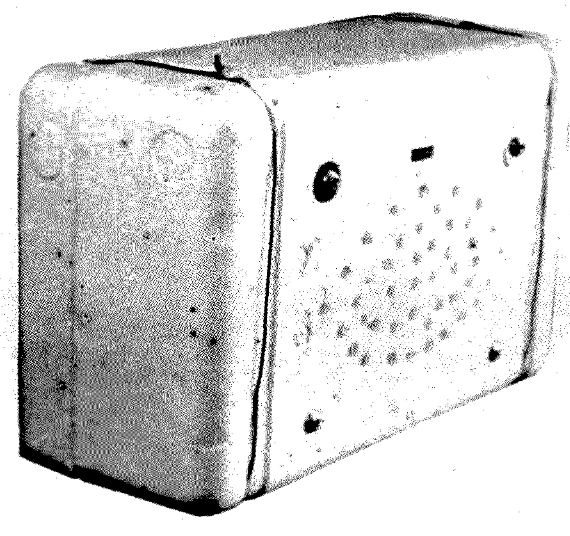
Cheap and Rugged Portable Speaker Enclosure

Having a spare speaker which we wanted to use for an extension from the shack when monitoring a net frequency and for the car when we went mobile, we found the perfect solution in the plastic foam boxes in which electronic equipment is shipped.

It takes only a little work with a knife to hollow out the inside to fit the speaker, plus an icepick to punch holes for mounting bolts. The porous nature of the plastic foam makes punching holes for the sound unnecessary, however, the material was so easy to work we punched the extra holes anyway.

The cushioning effect of the foam prevents damage to the speaker when moving it from place to place.

. . . Ross A. Sheldon K4HKD



Portable speaker case made from styrofoam box.

. . . . What I am trying to bring out is that we should clean our own house first. I'm sure that everytime you tune across an active ham band you will be able to find signals that are splattering across 6 to 8 kHz of the spectrum. I'd appreciate being notified if mine is doing that.

With the present conditions, and incentive licensing becoming a reality quite likely we will find that more, rather than less, used equipment is being made available to the CB'ers or whoever might desire to buy it.

Max Casselman WAØGSY
Conway Springs, Kansas

Dear 73,

Hail to Ron Zurawski! Finally, someone comes out with an intelligent view of SSB, as well as something to do about the CB mess.

His article contains some very good suggestions for what to do with the 11-meter circus which is now in full swing. The most important idea is to increase the FCC monitoring force. This is urgently needed. I know many CB'ers who work with well over 100 watts, and I even know those who have worked into the midwest and west coast with only five watts. The thing is, as long as there are CB'ers, there will be violators. Still, if the laws were harsher and strictly enforced, there would be less CB'ers, and much less violation.

So, bravo to WA8FVD.

Mark L. Cohen WN3HST
Philadelphia, Pennsylvania

Dear 73,

I'm writing in the hope that this letter may be published. My message is extremely simple. Lay off W1AW when code practice is being sent! I'm not interested in the views as regards ARRL, incentive, Don Miller or anything else. These are unimportant. The intentional QRMing that has been going on since the FCC acted on incentive does nothing to hurt ARRL; it only damages amateur radio.

I have the very great pleasure to teach an advanced theory and CW course for our local radio club. It is something that every capable ham should try when his time permits. Recently, my students have told me that the CW broadcasts sent by W1AW have been subjected to an increasing amount of QRM. Typically, they reported that the call-up for practice (QST de W1AW, etc.) is clear for almost the whole of the first five minutes. Then the fun begins.

At first, I was inclined to attribute the complaints to a lack of receiver selectivity available to some of my students. When some of them suggested that they were hearing signals zero-beating W1AW, I decided to check up on the reports.

A few nights of monitoring with a selective receiver was enough to convince me that something was going on. As a result, using an R4A+ Hamscan and an SB301+ monitor scope, I have literally watched the zero-beating occur and have even copied high speed CW QSOs in which the operators seemed to be proud of the fact that they were covering W1AW.

Gentlemen, and I am really using the term loosely, how low can you go? There is literally no excuse for this behavior. It doesn't help amateur radio a bit to keep new hams from licenses or keep those who already have tickets from advancement. Besides, it is clearly not legal.

William J. Webster, Jr. WB2TNC/8
East Cleveland, Ohio

Bill, if this is really going on, ham radio has reached a new low. A tape recording should be made and sent to the FCC and their monitor stations alerted. The casual QRM on W1AW is bad enough without malicious interference being added.

Dear 73,

I think you have the only ham magazine on the market. I do wish you would put all adds in a catalog section. I have fussed about this before.

I sure am enjoying back issues you had on special.

Orville Gulseth W5PGG
Clarksdale, Missisippi

Most advertisers prefer to be separated from the others, but perhaps we could convince them if enough readers voiced an opinion. Let me know how you feel about having advertising all in one place in the book.

Dear 73,

Thanks for the excellent November '67 articles on "I. C. Frequency Counter" and "I. C. Pulse Generator". Let's have more from WØLMD and W6GXN. Please give us lots of digital circuits using the Fairchild I. C.s (#900, 914, 923) as you have been doing

Bill Bentley
Westbury, L. I., New York

Dear 73,

The only reason I subscribe to your rag is so I won't miss the April issue. Being a long time fan of Harvey Kurtzman, I enjoy good satire. MAD never had it so good.

In a more serious vein, I would like to reminisce about an experience I had while stationed on Okinawa in 1962.

Being a rather new ham, all starry-eyed and full of the -uh- propaganda put out by the League, I wrote to them and asked if they could put me in touch with fellow League members. I also explained that it took about three months for magazines to reach the island and was there any arrangement whereby they could airmail QST to me. I would be glad to pay the extra postage. The letter I got back from them said, "Duh, Gosh, I don't know, maybe you could contact Okinawa Amateur Radio Club to meet some of the fellows". No mention of airmailing QST. I sent a similar letter to 73 explaining about the delay in getting the magazines.

I received, shortly thereafter (in a plain wrapper), an airmailed issue of 73, and I received them that way for the rest of my stay on Okinawa (about 22 months). I wrote Wayne asking what I owed for the courtesy he showed me, but I never received a reply. Perhaps it embarrassed him, getting caught out of his tough guy act.

Robert L. Katz WA5CZX
White Sands Missile Range, New Mexico

Dear 73,

I always wondered what Caveat Emptor above the ad section in 73 meant until I started studying Latin. Perhaps all of your readers who buy equipment from this section should get a dictionary of foreign words and phrases and look this up, hi.

Kenneth Bishop WA5MIN
Victoria, Texas

Dear 73,

We have just started the Radio Club Andino, located 10,000 feet up in the Andes Mountains; a group of construction men and miners, U.S. and Chilean. We are on the air on all modes 10 through 80 meters. CE2RE, CE2AD, CE2RG and CE2RM are all English speaking and could show up under the club call of CE2SA. Our QSL manager is ex-TG9BC. She hasn't received her call yet, but she will see that all club contacts are confirmed. If you want run-down on Chile, just QRZ.

Max Bond CE2RM
Los Andes, Chile

Letters

Dear 73,

My mail box is flooded with letters wanting me to renew my subscription to your fine publication. This warms my soul greatly. Now the last one states, "Throw my stencil out and save money". I am so sad that you are giving up, as 73 is the best damn magazine that I have ever received.

Now, it may be that my friendly postman may be high-jacking my monthly magazine and sending it to his daughter, who is in a home for unwed mothers, or the neighbors, who I give TVI to, but somehow we have our wires crossed.

So please check with the quite efficient young thing who handles the subscription renewals, and see what she has done with my twelve dollar check that I sent you on September 21, 1967. This was for a three year renewal, and I have not received any magazine since the one with the cute little "DANGER LAST COPY".

I already have the cancelled check back and know that somehow my name got lost in the pot, so would appreciate that you get me back in the groove and start the wonderful world of written confusion coming to my door again, and if the sweet thing blowed my twelve dollars on song, drink, and dance, that's all right, just get that 73 back in the mailbox.

Ray Winstead Evans WA5FDO
Marmaduke, Arkansas

Ray, we share your frustration and that of hundreds of other subscribers to 73 at the time we changed over to a new computer. The idea was to take advantage of the latest computer techniques for handling subscriptions. This would give us a much more perfect and rapid system of handling subs, as well as save us enough money to let us put off any increases in subscription rates for a while longer. The "routine change-over" went badly. Hundreds got their November issues very late, or not at all. Renewal forms were sent to hundreds of others who had already renewed. Normally we expect a few fellows to get renewal notices after they have renewed because it takes a few days for renewals to be made and it is not unusual to run off the notices during this period. Most subscribers realize this and just throw out the notice, but a few excitable ones write to us and Dotty gets a few minutes further behind checking his subscription to make sure that it really is OK. Hopefully, everything will be in good order by this issue. We are trying hard to give you the very best service possible. We are, by the way, the first ham publication to change over to a computer for subscriptions.

Dear 73,

In my opinion the whole controversy engendered by Jim Fisk's article condemning AM is very amusing. What both of the warring phone factions seem to forget is that there is a simpler, cheaper, and much more rewarding mode of operation. While the SSBer pays his kilobuck, and the AMer his centibuck to get on the air and fight the QRM, the CW who pays his decibuck and sets out confidently to communicate farther and faster, and derives much more pleasure from cultivating his skill than either of his more sophisticated cousins. After all, any boob can talk into a microphone. Anybody who says CW is outmoded, a waste of time, boring, ridiculous, etc., obviously doesn't know what he is talking about. When all else fails, my friend, and ham radio has lost it's thrill for you, try CW.

R. T. Wood WA3EPQ
State College, Pennsylvania

There have been hundreds of letters on the AM/SSB controversy. However, since Jim is no longer with 73, I refuse to carry on his battle for him. I think there is a place for all modes, and we have to find a means of living together in peace.

Dear 73,

Have tried TAG and can only say "WOW". My question went out and came back like now. Almost believe the postman answered it. Thanks.

Dick Heydt

Dick is referring to the Technical Aid Group. Elsewhere in this issue you will find a list of the members who devote time to answering technical questions from the readers of 73. On this score, may I ask that you keep a copy of this list handy and refer your queries to the appropriate member of TAG rather than to the Editor. I would like to be able to help you, but the job of production of 73 is a time and a half job and I just can't answer each question which comes in.

Dear 73,

Enjoyed K6BIJ's story on underwater radio signals. I'm sure it stirred the heart of many ex Sonarmen like myself. I served on a DDE for '51 to '55 and we had an underwater SSB rig that we could communicate with subs by either voice or CW. It was called the "Gertrude" for some unknown reason. The official Navy designation was something like AN-UQCO1. It worked quite well and the "antenna" was inside the sonar dome beneath the ship. We used to have CW drills with other destroyers using it at ranges of about 1000 yards.

Also to kind of answer K6BIJ's question, we were taught and of course found to be true, that salinity, pressure, and density affect sound in water. Sound tends to bend away from warm water too. Sound in water traveled at about 4800 ft/sec, and increased as the salinity and other factors went up.

Don McCoy WAØHKC
Wheatridge, Colorado

Dear 73,

Please keep up the good articles!! I dropped the other two mags and am reading Tom Swift books instead, I notice little difference between them and the "other two"; they're both far-fetched!

Thomas Dulisch WA9TDD
Park Ridge, Illinois

The Death of Amateur Radio

Dear 73,

I have just finished reading the article, "The Death of Amateur Radio" from the November issue. I wondered if you bothered to do the same? I am very surprised to think you would print such trash.

Richard N. Burne K3KAW
Scranton, Pennsylvania

Dear 73,

Having read 'The Death of Amateur Radio' by WA8FVD, I have some opinions to express.

First of all, his idea of keeping old AM equipment when purchasing new rigs is, in my opinion, absurd. Suppose for example, we all kept our old automobiles when buying new ones because we might not like the prospects of where our old vehicles would go or for what they might be used.

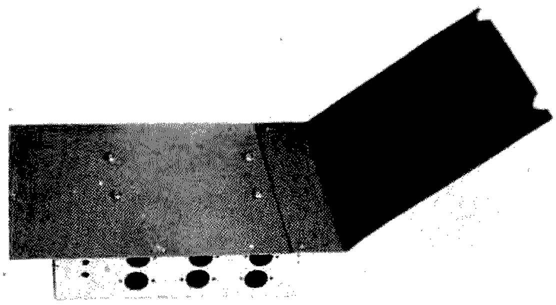
The XYL Pleaser Mobile Mount

The XYL put up with having the rig in the car on trips, but served notice she wanted nothing left in the car when the rig was returned to the shack at the end of the trip.

So—an old U-shaped chassis was found which, turned upside down, fitted over the hump in the floor boards. Two pieces of metal were bolted to it and one of them bent upwards to rest against the front of the seat cushion. Two notches were filed in the end of the upper piece to receive the front legs of the SR160. A portable speaker in a plastic box was wedged on the metal platform between the rig and the engine firewall.

It takes only ten minutes to install or remove the rig and the only things left behind are the power cable and coax.

. . . Ross A. Sheldon K4HKD



The XYL pleaser mobile mount.

LINE OF SIGHT

We hear much about the so called "line of sight" on UHF and VHF bands but after mentioning it, not much more is known; especially how to figure it.

Lets say you have a fifty foot tower on the old 2 meter beam. What is your line of sight? 50 miles, 25 miles, 10 miles, 5 miles?

There is a simple formula for calculating this distance. It is D(distance in miles) = $1.23\sqrt{\text{Height of antenna}}$. The squart foot of fifty feet is 7.07. Multiplying this by 1.23 we have 8.69 which is your line of sight from the tower at the antenna.

Actually the radio horizon is 15% more than this or a total of 9.99 miles. If you wish to figure it even more quickly simply take the formula of (Distance in miles) = $\sqrt{2H}$. This works out to 2 times your height —100 feet and take the square root of that which would be 10 miles.

This is "YOUR" line of sight. If the fellow is on the other end, his line of sight is figured the same way and is additive. In other words, his line of sight is say—eight miles. Yours is ten so you have a line of sight of eighteen miles.

This is why the fellow with the higher tower gets out a bit better even though he may have the same rig etc. etc.

(Tongue in cheek) As you raise the tower, so do you run up the losses in the coax feed line. You can't get something for nothing—or hardly.

. . . Bill Roberts W9HOV

Conference. It has been several years since I've had a chance to see all my friends out there, so don't disappoint me.

On June first I will be speaking at the Swampscott ARRL Convention and showing some of my African slides. After being excluded for two years from this affair it will be nice to get back and see everyone.

May I caution convention committees not to get all excited and expect me to be available. First of all I will be tied down at 73 for quite a long time to come and it is extremely difficult to get away even for a day. Secondly, my wife Lin will be coming with me anywhere I go, and we just don't have the money to make extensive jaunts. The bookkeeper complained the other day that she needed a bottle of black ink, but that if she bought it we would be back in the red again.

. . . Wayne

Our Advertisers

The advertising in 73 is as important to you as it is to us. As I've mentioned before, it is the advertisers that are paying for the magazine, since the subscription money just barely covers our cost of sending out the magazines. If you like a bigger magazine then it is up to you to encourage advertisers to use 73. We try to run about 30% advertising, running a little under that now and then and a bit higher at times to get back even again. This means that every page of advertising is bringing you two pages of articles.

You can help us a lot with this. When you write to advertisers ordering something for heaven's sake please tell them that 73 tipped the balance. If you've got a gripe tell them someone else sent you.

I know that a lot of you are buying Heath equipment, but you sure haven't told Heath about it. From now on, when you send an order to Heath for something, mark it to the attention of Earl Broihier. Earl is in charge of advertising up there. Don't let me down on this; show him that the 73 readers are good customers and that you want to see more Heath advertising in the magazine. Fold down the corner of this page so that you can remember to mark your next orders to Heath to go to Earl. Don't forget!

that one. My head ached and every muscle and joint in my body was wracked with pain.

By late morning I was feeling a lot better. Joe stopped by and we talked a bit more. He wanted me to send him some strings for his badminton raquet from Bangkok and gave me the sizes for clothes for his family so I could send some when I got back home. They need everything, but clothes are the most wanted.

When the airline bus got me to the airport I found that Royal Thai had not notified the immigration people about my delay. They raised a big fuss over this and seemed about to haul me off to jail. I got them to tackle their phone system and call Royal Thai. They finally managed to get through and reluctantly stamped my passport for the extra 24 hour visa.

Burma was certainly interesting, but I don't think I'll go back right away. A couple hours later we landed at Bangkok where I was met by John Nolan, a chap who used to work for us in Peterborough a couple years ago and who at this time was with the U.S. Army in Korat, Thailand. He got a couple of days off to do Bangkok with me.

Things are still very rough in Burma and, if you ever have a notion to do some good, you might just drop a note to one of the fellows listed in XZ land in the Callbook and find out what you can send him that will be helpful. I've been corresponding with Joe and have sent over a big box of clothes for him and his son.

Public Appearances

For the last couple of years I have not been at my best and I have thus tended to avoid hamfests and conventions as much as I could. I'll probably be getting out a little more this year and I would like to meet as many readers of 73 as I can. Say hello, and tell me what you think of the magazine . . . what would improve it . . . what isn't so hot . . . etc. And give a lot of thought to ideas for pepping up our hobby.

First I'll be speaking after the dinner given by the Northern New Jersey DX Association on March 23rd at the Holiday Inn, Wayne, N.J. This is at the intersection of routes 46 and 23. The program starts at 2 PM and the banquet at 7. Write W2PXR for details and a reservation. Be there if you can.

On May 11th I will be the guest speaker at the Western New York Hamfest and VHF

and you have to worry about stepping in strange substances like betel nut chewings, little bright red wet splotches that are around in profusion, or nice surprises left by rather large dogs.

You don't just in and out of a pagoda. This monster was the size of a very large city block and had small temples for each area of the country, with places to sit, rest, worship and even eat. There were all kinds of Budhas . . . sitting Budhas, reclining Budhas, standing Budhas. The professional prayers were hard at work burning candles and praying loudly at many of the shrines, pouring water over the Budha in the shrine.

We stopped several times at the Royal Thai Airline ticket office to make sure that my flight out was going to be on time. The fellow in charge unfortunately couldn't speak English so we had a little problem. He tried several dozen times to get in contact with the airport by phone, but the telephone service is run by the army with the same efficiency that they run everything else and it wasn't until about noon that we finally made contact. My flight had been cancelled and Royal Thai would see that my visa was extended one more day. They would also pay my extra day of hotel and meals.

This was nice, but I was feeling more and more ill and I was not at all anxious to come down with something serious in a country which had hospitals run like the telephone service. I had the distinct impression that they might just ship me out of the country on a stretcher, if this was where I was when my plane left. I would much rather get sick in friendly Thailand.

I managed to last through a nice Chinese lunch with Joe and a visit to the Rangoon zoo, but I was weakening badly when we went to an afternoon billiard tournement. I did have an opportunity to talk with a chap from the British embassy who backed up everything Joe had told me about Burma. They wanted to take me out to dinner after the match, but I was about ready to pass out and just got back to the hotel in time to drop into bed for the night. I couldn't even eat the free Royal Thai meal.

During the night I was violently sick, complete with a raging fever and icy chills. There were two beds in my room and I put all the blankets on one and crawled underneath to shiver. The room was about 90°. When I soaked the bed completely I moved the blankets over to the second bed and used

a bicycle he can get a ration book for it which permits the purchase of one tire per year at about $40.

Joe pointed to the receiver up on a shelf and said wistfully that he tunes twenty meters now and then just to listen in. There seems little hope that amateur radio will be permitted again in Burma for a long time. He saw that I was having trouble believing that things were so bad in Rangoon and said that he would take me on a short tour of the town when he drove me back to my hotel. The car? Well, the army used it until it fell apart and refused to run any longer and then returned it. He and his son managed to get it working again and kept it just barely running so they wouldn't take it back again.

We drove through Rangoon at 10 pm and, as he said, everything was closed. Everything. I explained that I had to catch a flight out the next afternoon since it is impossible to get more than a 24 hour visa. Joe said he would show me the town in the morning so I could see for myself what it was like these days.

When I asked him about Don Miller's visit and how Don had managed to stay in the country for two weeks and get permission to operate when the locals were not allowed on the air, Joe said that as far as he had heard from the other hams in Burma Don had never been there. They had heard about Don's "Burma" operation, but were quite sure that he could not get a license or be permitted to bring any equipment into the country. Also there was virtually no way to overstay a 24 hour visa without going to jail. He said that the Burmese hams were convinced that Don had operated from somewhere else, probably Thailand.

The next morning Joe drove up to the hotel in his jalopy and picked me up for the grand tour. Sure enough, as he had said, almost every store and factory in the city was closed tight with barred doorways. The main department store for the city (run, like everything else, by the army) had virtually no merchandise. The little government food stores had small dirty boxes of the grimiest rice and beans you ever saw, and little else.

Next we started on the pagodas. The biggest one is right in the middle, of town and it is a corker. The big problem, for a tenderfoot like myself, is that you must remove your shoes to visit the pagodas. This is no problem if your feet are accustomed to walking on tiles that are baking in a tropical sun.

ELECTRONIC/COMMUNICATIONS SLIDE RULE, "Ricoh" Model 156LAI computes L, C. F_o, X_c, X_l, ± db, and many other most used formulae in three settings or less. Seventeen red or black 10" scales (±db, DF, CF, CIF, CI, C, D, A, X_c, X_l, K, KI, S, T, F_1, F_2, DI) engine engraved on hard glare-free white plastic, bonded to warp resistant laminated bambo. Accessories: Genuine leather case, plastic decimal point table, instruction booklet. Made in Japan. Save $9.00!! Cash price prepaid to any US post office . . . $15.95! Yukon Electronic Sources, INC., Drawer "O", College Alaska 99701.

9½ by 10½ CLOCK CONVERSION CHART. Reads all times at a glance, a must for every ham shack. Only .75 check or M.O. only. J. F. Siemietkowski, 3039 East Thompson St., Phila., 19134 Penna.

IDEAL COMPANION FOR HT-44 Hallicrafters SX117, receiver. Needs slight repair. $225 or best offer. Rob Martin WB2WBA, Box 36, Katonah, New York 10536.

GOODIES, cash for Teletypewriters, parts. List. Sell 14s, 15s, 19s, 28s, parts. Toroids, 6/$2 postpaid. Typetronics, Box 8873, Ft. Lauderdale, Fla. 33312.

HALLICRAFTERS SX140 Novice receiver, 80-6 meters, $65 shipped in continental U.S. Heathkit DX-100, good condition, FOB Lynn Ziegler WA5LTC, Route 3, Denison, Texas 75020.

HEATHKIT SENECA VHF-1, six and two meter transmitter, looks and operates fine, only $145.00. K1PNI, 133 Larchmont Road, Warwick, R.I. 02886.

POWERSTAT, type 136, 20 amps, brand new, includes triplet 0-150 vac meter, only $30.00. K1PNI, 133 Larchmont Road, Warwick, R.I. 02886.

EICO 720 perfect $60. 75A-2 $175. ART-13 nice unmodified $25. K8ZID Henry S. Allgyer, Gnadenhutten, Ohio 44629. 614-254-4172.

HY-GAIN 153-B full size three element 15 meter beam, $22.50. Also BC-696A $12.50. W6IH, 12252 Hartsook St., No. Hollywood, Calif. PO 1-8979.

HW12, 22, 32, OWNER ("A" SERIES ALSO): Convert your rig to three bands with SSB & CW coverage. Send $3.95 for assembly manual or 10¢ for illustrated brochure. DRC, 215-28 Spencer Avenue, Queens Village, New York 11427.

HRO60 100 kc-54mc,spkr. $289; HQ-180C, spkr. $169; HC-10 SSB converter $100; all like new. T. C. Howard, 46 Mt. Vernon St., Boston, Mass. 02108.

WANTED: R-390A/URR, 51J-4, R-388, Model #28 Teletype, etc. Cash or trade. Alltronics-Howard Co., Box 19, Boston, Mass. 02101 (617-742-0048).

STEP ATTENUATOR, Kay 432d, precision, -0-101db in 1 db steps, 50 ohm, good to 500 MHz. $50 ppd. Herbst, 2F, 3001 Edwin, Fort Lee, N.J. 07024.

6 METER CONVERTER, 3 FET transistors, Printed circuit board construction, 14MCs output, less power and xtal, $8.50 FOB. Bill Deane, 8831 Soverign Rd., San Diego, Calif. 92123.

TELETYPE TEST SET I-193C. Brand new surplus. Tests RTTY transmitters, converters, relays, $24.95, F.O.B. Harrisburg, Pa. Telemethods International, P. O. Box 18161, Cleveland, Ohio 44118.

B-C FLIPS THE LID ON SURPLUS

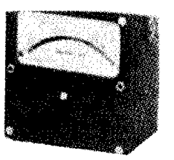
TV-10/UHF-VHF transverter, 8 channel crystal controlled ARC-12 transmitter, 228-258 mc and receiver-converter, converts incoming 228-258 mc to 118-148 mc to feed into R-19/ARC-12 receiver, using 110 mc crystal oscillator. NEW, with instruction book. $35.00

R11A/ARC, complete with all tubes, has hi-Q ceramic 85 kc i-f's (see Sept. 1963 73 "Q-5er Reborn"). Very excellent used (12) $15.95

IP274/ALA10, 2 meter panoramic adapter, 30 mc± 5 mc input, 400 cy power supply with instructions for solid states 60 cy supply and to 14 mc input Internally complete, 3BP1 & 17 tubes. Excel. (45) Reduced to close out $15.00

MN-26LB, Bendix direction finder & communications receiver. 3 band, 200-410, 550-1200 kc, 2.9-6 mc. Internally complete, 12 tubes. Excel. used (40) $12.95
MH-20D loop antenna for above, not rotable. NEW $1.95

Lazy Man's Q-5er, 1020 cycle filter, 3 position switch-RANGE passes 1020 cycle VOICE rejects 1020 cycles, both no filtering. A "MUST" for CW & Teletype. Lowest price. NEW (3) $2.25



WESTON model 742, AC/DC mirror scale, accurate voltmeter. DC scales 0-30 & 0-300 v. AC scales 0-1.5, 0-15 & 0-150, 4½" square, provision for edgelighting; complete with all necessary multipliers, on an assembly 1 ma DC basic movement. BRAND NEW $20.00

Hamfest schedule: Wheaton Swapfest, Du Page County Fairgrounds, Feb. 18th.

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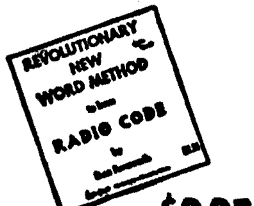

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73

MARCH 1968
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73 MAGAZINE
Peterborough, New Hampshire 03458

March 1968
Vol. XLVII No. 3

Kayla Bloom W1EMV
Editor

Published by
Wayne Green, W2NSD/1

Cover

K6MIO Dishes up a measured 16.9 dB with his 12.5 foot antenna at the Fresno VHF Antenna Measuring contest. He won the contest.

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $12.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

Recently, on TV, there has been a series of ads put out by the Cancer and Heart Associations showing how children learn from their parents and tend to imitate their actions. These ads all end with the question, "Do you smoke?". Now, I am not going to give you any lectures on smoking, since I use the filthy weed myself. I merely use this to illustrate a problem we have in ham radio.

About a month ago, I was at a luncheon meeting where an ARRL Division Director loudly complained about the terrible operating habits of the newcomers to ham radio. He droned on and on about how the newcomers were ruining our chances for frequency allocations and are to blame for all our troubles in amateur radio today.

I can't help thinking that as the child learns from his parents, so the newcomer learns from the old-timers. Incidentally, the definition of an "Old Timer" is anyone who has been licensed longer than you have. It is the obligation of each ham to see that his operation on the air is courteous, legal, and within the bounds of good manners. This is not too difficult, but we should all remember that someone new will be learning from us.

My dictionary defines the word "communicate" as: An exchange of ideas by speech, writing or signals. Note that it says *ideas*. Listening to the average QSO on the air, I get the feeling that there is little communication going on. There is an exchange of *information* such as the kind of rig, the signal report, names, addresses, and a FB OM, CUL ends the contact.

There is no set formula for getting a QSO going on an exchange of ideas, but we should try to toss out some tidbit to begin a stimulating exchange. Granted, there are some who are not interested in communicating and nothing you will say gain more than "By the way, what's the rig on that end". However, with the majority a leading question like "What is your occupation?" will usually draw a response and will be countered with a question which will give you something to go on and thereby begins a *communication.*

The exchange of ideas is especially rewarding in a QSO with a station from another country. Granted, Rag-Chewing with "rare" DX is frowned upon, unfortunately, and in these cases all you can hope for is an exchange of information, *not* ideas. But the less exotic DX is usually not only willing, but eager to talk, not only about rigs and antennas, but about themselves and their families. They will answer questions you may have about their way of life, and furnish the opportunity to travel while sitting in the ham shack. The most rewarding part of this kind of communication is the friendships which often develop and grow over many years. Try communicating once in a while and your enjoyment of ham radio may increase.

Having spent the past month searching the files to see just what interested articles are available for future issues, I would like to call for authors to produce. For the past year, there has been a lax policy about prompt payment of authors. I was shocked to find that there were dozens of authors who's articles had been accepted, but who had not been paid on acceptance. As of now, this has been rectified and all payments are current. *They will remain so!* The payment policy is payment on acceptance. The system goes like this: You send in an article for our consideration. If, in my judgment, it is suitable for 73, I will write you a letter accepting it and telling you how much your payment will be. As soon as you accept my offer of payment, a check will be sent to you and your article will be processed for publication as quickly as possible.

At the moment we need VHF articles. The magazine has neglected the VHF angle for the past year and the files are bare. Of most interest would be construction articles using ICs. No conversions or modifications of commercial gear, please, unless they are really unusual and have the approval of the manufacturer. Commercial equipment reviews will usually be rejected unless you are well known to us and have done writing for us before. However, if you

(Continued on Page 84)

de W2NSD

never say die

The latest issue of Interadio, the International Telecommunications Union publications, has some sobering words for amateurs. We have our amateur radio frequencies not, as so many amateurs believe, as a gift from the FCC, but as the result of the ITU agreement between 133 countries. And if we lose our frequencies they will not be lost at Washington, but in Geneva.

Few amateurs in the U.S. realize just how precarious our position really is. Most of those 133 ITU member countries are on record as being officially in favor of cutting our amateur bands and, if they are ever given the chance, it is quite likely that we will come out of the conference badly pruned.

Time is on our side. Technical developments will eventually relieve the pressure on our bands as other services change over to cables and satellite communications. This may be in the near future here in our country, but it is still further off than most other countries can see. So, in the meanwhile, we will continue to exist as long as a new ITU conference can be stalled off.

Amateur radio has friends in high places in the ITU and in many foreign governments. An understanding of the long range benefits of amateur radio is gradually becoming more evident in many countries. They are beginning more and more to realize that amateur radio is much more than a hobby for the wealthy, it is a primary training ground for electronic technicians and, frequently, one amateur station can reach more of a listening audience than millions of dollars spent on short wave broadcasting.

The Interadio editorial says, "There is one thing going on in the amateur world today that bids fair to cancel out all our attempts to popularize and publicize amateur radio with the world's radio Administrations. Some amateurs, on DXpeditions, have been using call signs that they themselves invented for the purpose and which are registered nowhere officially. To quote No. 735 of, the Radio Regulations, Geneva, 1959—these are the international regulations governing radiocommunications of all kinds—'Transmissions without identification or with false identification are prohibited.' Now that is clear and unambiguous, and that writ runs in the 133 Administrations of the world that are members of the ITU. We all know that a stiff fight is ahead for us to save the amateur bands, and so it is the height of folly for any amateurs to be so thoughtless as to present the opponents of amateur radio with a first-class, legal, and unanswerable case that radio amateurs are using their bands irresponsibly."

The "they" in this case seems to be Don Miller and his self-appointed prefixes such as 1S9, 1M4, 1G4, etc. These prefixes are absolutely illegal and I am surprised that the FCC has not taken action to reprimand Miller for his flagrant breaking of international law. I am also disappointed in the ARRL for giving credit for some of the operations using these illegal call signs. It wouldn't surprise me if the ARRL were to reconsider their earlier hasty decision in this manner and delete DXCC credits accordingly.

Perhaps CQ will also reconsider their decision to champion this man who is such an international disgrace to amateur radio. Perhaps they will also name a new winner for their DX contest, which Miller supposedly won from Minerva Reef using the made up 1M4 call. Those of you who enjoy doing a little research will be interested in comparing the Miller pictures and description of Minerva Reef with the book Minerva Reef by Olaf Ruhen published in 1964 by Little, Brown. After reading the book one wonders just what Minerva Reef Miller visited.

Well, enough about Miller, I think he has been grounded by the DX fraternity. The harm that he has done is incalculable. This means that all of us are going to have to work that much harder if we are going to see amateur radio through the hard days ahead. And there is much that we can do. . . every one of us can help.

While not many of us are in the position where we can go traveling around the world talking with the radio Administrations in the foreign countries, selling the benefits of amateur radio to them, we are in a position to get on the air and see that amateur radio puts its best foot forward to the world. All of us have a clear responsibility to keep our bands as clean as we can. When you hear someone on the air making an ass out of himself you should delegate your-

Fred Berhley WB2CPG
32-16 Crescent St.
Astoria, L.I., New York 11106

Narrow Band Frequency Modulation

Introduction

The NBF Modulator to be described has been designed around a component known as a Voltage Variable Capacitor and is being sold under the tradenames of Varicap by TRW Semiconductors Inc. and Semicap by the International Rectifier Co. The writer has found no appreciable difference, performance wise, but local availability has sometimes dictated choice.

Electrically they are diodes, have polarity, are fairly unaffected by heat, are voltage sensitive and are usually reverse biased with a low dc voltage when used as a Narrow Band Frequency Modulator. They are the simplest, least costly frequency modulating device available and are capable of providing 100 percent modulation for a kilowatt transmitter at full CW rating at a cost of less than $5.00 for the modulator and a stage of microphone pre-amplification.

Physically, they are the size of a quarter watt carbon resistor for the Varicap and a top hat rectifier look a-like for the Semicap. In spite of their small size, they are capable of performing functions normally requiring tubes or bulky mechanical equipment. We have in mind mechanical sweep mechanism, or saturated choke inductors such as are used in sweep signal generators or similar instruments calling for frequency modulation.

Used as a NBF modulator, the Voltage Variable Capacitor, hereafter referred to as V.V.C., will change capacity with application of any voltage across it's terminals, and the resulting change will be nearly linear for a comparatively large change.

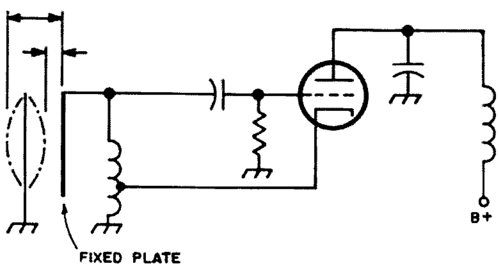

Fig. 1. Capacitor microphone frequency modulator.

See **Fig. 3**. Since the V.V.C. as a frequency modulator becomes part of the oscillators tuned circuit, any fraction of audio voltage across it's terminals will cause the V.V.C. to change capacity in step with the applied, audio voltage, thereby producing almost perfect *direct* frequency modulation. The frequency change, due to the audio voltage, appears to be linear over a fairly wide frequency deviation from resting or center frequency.

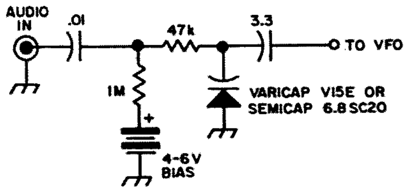

Fig. 2. Basic varicap frequency modulator.

Frequency modulating systems:

The V.V.C. as a modulator is possibly the nearest thing to the classical example so often described in textbooks; wherein the tank coil of an oscillator is shunted with a capacitor microphone; and where the minute capacity variations of the microphone, when spoken into, add to or subtract from the total static capacity across the oscillator's tank coil and in this manner produces Direct frequency modulation. A seemingly simple idea which never did work out well in practice. One of the main reasons was of course the required use of the highly special and costly microphone, since no other microphone available could provide the necessary capacity variations.

The only restriction a V.V.C. imposes upon an oscillator to be frequency modulated, is that the oscillator is not of the extreme stability type. Crystal controlled and some high C/L type of oscillators do not lend themselves very readily to the *direct* type of frequency modulation. Crystal controlled frequency modulated transmitters usually employ the *indirect* or phase modulation method, in which modulation is introduced into a

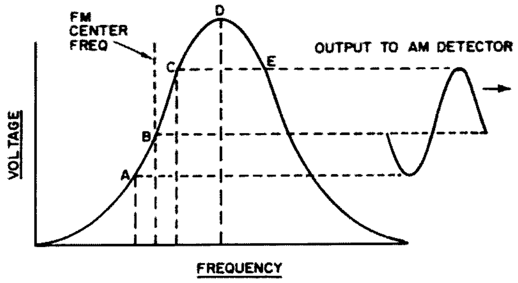

Fig. 4. Slope detection.

the transmitter, in this case, is set at a lower level than normally is used, in order to match the bandwidth of a possibly very selective receiver. If all conditions are right, the only indication a receiving station may experience, is a low S meter reading with considerable audio.

For a better understanding of the slope detection method, **Fig. 4** and the following, should be helpful. Admittedly, slope detection is not the most desirable way to receive an FM signal. For amateur use of NBFM, where the total bandwidth is usually less than 5 kHz, slope detection can, and will, produce a pretty good audio signal at the receiver's output. For the ultimate in FM reception and to do full justice to a still very fine mode of communication, with it's many advantages over AM and even, under certain conditions, the SSB mode of operation, a receiver of the limiter-discriminator, limiter-ratio detector or quadrature detector type is a must. In spite of it's seeming shortcomings, slope detections permits the owner of an AM receiver to copy NBFM signals in pretty good style. That is something which could not be done with the same receiver trying to copy SSB without the benefit of a product detector and/or a BFO.

When the carrier of an NBFM signal falls on the sloping side of the rf response curve (See **Fig. 4**) in an AM receiver, the frequency variations of the FM carrier are converted into equivalent amplitude variations. This conversion results from the unequal response above and below the carriers center frequency at point B on the curve. Consequently, when the incoming signal is less than center frequency at point A, the output voltage is at it's minimum or negative value and when the signal swings to point C on the curve, the output voltage is at it's maximum or positive value. This available voltage can be fed to the regular AM detector where the original FM audio will be recovered. The obvious nonlinearity of the response curve would be detrimental to wide band FM reception using the slope detection method, since the most linear portion of the response curve has a limited frequency response. With NBFM, where the required frequency response is limited to voice frequencies of approximately 3000 Hz maximum, the undistorted output voltage available can provide a fairly good audio quality from an NBFM signal.

Finally, if the NBFM center frequency is permitted to fall on point D of the rf curve, the maximum frequency swings would fall between points C and E, and, because of the relative flatness of the curve, there would be no effective output signal. Under actual receiving conditions, this would manifest itself as a big carrier indication on the S meter with practically no audio, and the receiving station would report the NBFM transmitters signal in these terms.

Those wishing to take full advantage of NBFM operation, are handy with simple tools and are familiar with FM circuitry, won't find it too difficult to add a small ratio detector or quadrature strip to their present receiver. Hints and circuits can be found in the ARRL handbook in the chapter on specialized communication systems. To the readers who may question the effectiveness of slope detection, it can be stated that the signal strength thus received is about one quarter of an equivalent AM signal. It should be remembered however, that the FM signal in nearly all cases is received at a 100 percent modulation level, especially if the FM signal bandwidth matches the receivers.

Adding the NBF modulator to the VFO.

Fig. 6 shows a complete and practical NBFM—VFO circuit, which incidently happens to be a copy of the writers own 2 meter rig, and the tube version in **Fig. 7** for the 6 meter transmitter. The battery operation in Fig. 4 has been replaced by the power source circuitry in **Fig. 5** after giving excellent service for over two years. Where desirable, battery operation is practical and economical, since current requirements are low for the circuit in **Fig. 6.**

It should be remembered that, when installing a V.V.C., the nominal capacity of the V.V.C. (which is determined by the bias voltage) is in series with the small coupling capacitor (3.3 pF in **Fig. 2.**) and shunted across the total tuning capacity of the oscillator. The result is, of course, a

stage following the oscillator, thereby permitting the transmitter to be fully modulated and still retain the stability advantages of crystal control. Phase modulation is not within the scope of this article and was mentioned solely for the benefit of those who may be tempted to try frequency modulating a crystal controlled oscillator by the *direct* method.

Cost of NBFM

For the "home brewer" with a limited budget, NBFM is a real money saver. The cost of a good AM modulator for a kilowatt rig could be prohibitive for a fellow with a thin pocketbook. The price of complete NBF modulator including a microphone amplifier need not be more than the price of a single medium power AM modulator tube. Although very low in cost, the NBF modulator has the built-in capability to produce 100 percent modulation for any transmitter from 1 to a thousand watts and at full CW ratings as previously stated.

The total space required for the NBF modulator and pre-amp as shown in **Fig. 6** is less than a matchbox and the total weight less than 3 ounces with no power wasting or heat producing components in its circuitry. Amateurs with outboard VFO's should find it particularly easy to add NBFM operation to their transmitter, without having to give up their AM mode, by installing a NBF modulator and pre-amp in the VFO and by disabling the AM modulator, which in many cases requires only to switch to CW, where this provision is available. To acquaint those readers who may have had little or no experience with frequency modulation of the *direct* type, a basic V.V.C. circuit is shown in **Fig. 2.** The oscillator to be frequency modulated may be of any standard design and the V.V.C. should be connected to the oscillator with the shortest leads possible. The more affluent members of the amateur fraternity who may be fortunate enough to own a P & H, or similar, compression amplifier may, with a few minor changes recommended by the manufacturer and shown in his instruction sheet, use the compression amplifier instead of microphone pre-amplifier shown in either **Fig. 6** or **7.** With the recommended changes the P & H will deliver slightly more than 1 volt of audio with approximately 10 to 15 mV, input which is more than needed to produce frequency deviation to the full

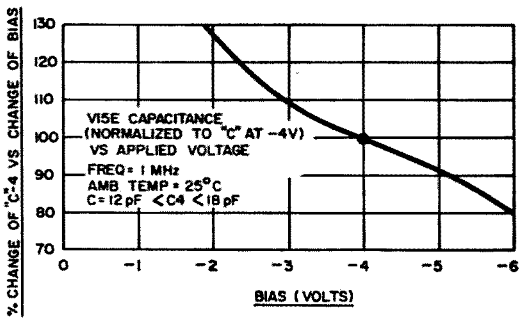

Fig. 3. Frequency variation at 1 MHz with a Pacific Semiconductor VO15E voltage-variable capacitor. Typical capacity (25° C) is 12 pF.

legal limit at the transmitter's output frequency at **6** meters. The compression amplifier is simply connected between the microphone and the audio input terminal of the modulator, best shown in **Fig. 2.**

Receiving NBFM signals

Receiving NBFM signals should pose no great problems, since almost any AM receiver, with the possible exception of the Heath Sixer, can receive NBFM signals using the slope detection method, which requires nothing more than a slight detuning from the NBFM carrier's center frequency. The amount of detuning required depends a great deal upon the rf response curve of the individual receiver. Audio quality obtainable from an AM receiver using the slope detection method, is mainly a function of the receivers bandwidth to match the deviation width of the NBFM signal. Receivers with a 5 to 8 kHz bandwidth should have absolutely no trouble receiving an NBFM signal with a deviation level of 4 to 5 kHz. The more selective receivers with a 2.1 to 4 kHz bandwidth can easily be accommodated by reducing the deviation width at the transmitter.

The writer has had many fine QSOs with stations having some very selective receivers with bandwidths around the 2 kHz mark and has had some very good audio reports at that. In some cases the receiver's owner was not even aware of the fact that he was listening to an NBFM signal. This however, can happen only if the listeners receiver *and* transmitter are tuned to the same frequency. The FM transmitter is then tuned to the listeners frequency and finally backed off slightly from this frequency, which is reality is nothing more than slope tuning in reverse, and is done at the transmitter instead of at the receiver. Frequency deviation at

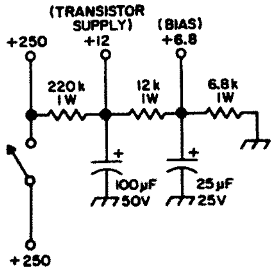

Fig. 5. Alternate transistor supply and bias source for Fig. 6.

small shift in the VFO's dial calibration. With VFO's having 100 or 500 kHz calibration points, this effect will be negligible. Those who own a precision calibrated frequency meter type of VFO, can easily restore the original dial calibration by a very small internal trimmer adjustment, or, if provided, a small tuning slug adjustment of the VFO's tank coil.

With no audio exitation from the microphone, the NBFM modified VFO will deliver a steady rf signal. This is why a NBFM-VFO with no audio input can still be used as the VFO for the original AM mode. Since many of the popular VFO's for the six meter band operate at fundamental frequencies of 8 to 9 MHz and are using the transmitters multiplier stages, with a multiplication faction of six to obtain output frequencies of 50 to 54 MHz, the actual frequency deviation at the VFO's fundamental frequencies is very small, percentage wise. To be more specific; the proper deviation for NBFM is about 2000 Hz based upon an upper audio frequency limit of 3000 Hz with a deviation ratio of approximately .7 at the *output* frequency. This deflection is about equal to 100 percent modulation on voice peaks, and since the accepted deviation for NBFM is 2000 Hz, the required deviation at the VFO's fundamental frequencies would be (taking into account the transmitters multiplication factor of six) . . . ⅙ of 2000 Hz or roughly 333 Hz. It may be interesting to know, that the total capacity change required to cause a 333 Hz deviation is *less* than 1 pF, and it takes less than 1 volt of audio to produce this frequency swing.

A good rule to remember when using any V.V.C. as a frequency modulator, is not to exceed the V.V.C. operating voltage, and that for proper NBFM operation, the bias voltage for the V.V.C. must be set high enough to prevent the sum of all voltages, dc, peak rf, and peak audio, from driving the V.V.C. into it's forward or conducting region.

In the circuit shown in **Fig. 6,** the output from the one stage of audio and a high impedance microphone is more than enough to fully modulate any transmitter. It should have become clear from the above given figures that it is rather easy to overdeviate or modulate any NBFM transmitter. A word of caution to the home brewer who may be building his own favorite VFO. A carelessly built VFO can actually produce frequency modulation without the aid of an V.V.C., but it will be of the incidental or illegal kind, frowned upon by the powers that be. The writer has copied many AM stations with a strong FM content on their carrier and can often read considerable frequency deviation of the AM carrier on his deviation meter. A clean AM signal is dead, audio wise, on it's center frequency, when received with a properly operating FM receiver.

Before leaving the NBFM—VFO subject, the writer would like to say, that he is fully aware of the many types of silicon diodes available on the surplus market which may be suitable for application as a V.V.C. However, the audio requirements of these surplus diodes may be more demanding than the simple, single stage of preamplification shown in **Fig. 6** and **7** can provide, thereby offsetting, quite possibly, the price advantage of a surplus diode of unknown performance.

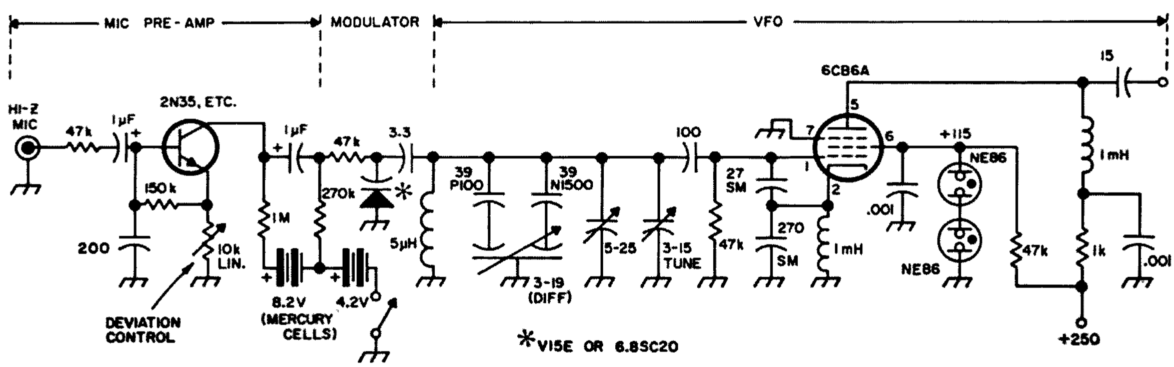

Fig. 6. Practical 8 MHz direct frequency-modulated VFO with battery operated transistor pre-amplifier.

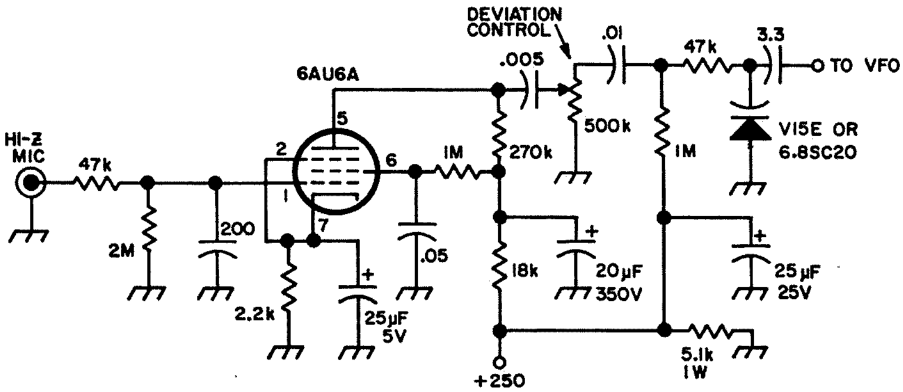

Fig. 7. Vacuum tube version or Fig. 6.

Conclusion

Up to now, the writer has deliberately refrained from making any direct comparisons between the various modes of communications and is fully aware that the next lines will bring forth some very strong disagreements, especially from the SSB addicts. The writer, having been around FM longer than he cares to remember, believes that; CW is more efficient than either AM, FM and SSB and that SSB is more efficient than AM and that FM is better than either AM or SSB, . . . *up to a point.* The definition or location of this point is not too difficult, especially on 6 meters, since the 6 meter band has not been a spectacular DX band, skip conditions excluded, and ground wave reception, even when conditions are favorable, do not extend regularly for thousands of miles, therefore a six meter NBFM signal can fall easily within this "point". There is nothing mysterious about this point, it is simply the distance in miles from the NBFM transmitter, where the signal produces the "threshold of improvement effect," or in plain words, where the signal is strong enough to provide adequate limiting in the FM receiver. At this point, FM is better than AM, as good as SSB, and at points closer to the transmitter, where heavy limiting occurs at the receiver, FM comes up with a distinct advantage over either AM or SSB. There are several ways to substantiate these claims. One of the more easy to understand is the S/N vs. Pathloss in dB application where, by means of graphs, the efficiency of either mode of communication can be readily demonstrated.

With a properly operating FM system of transmitter and receiver, and a signal within the limiting range of the receiver, there are many advantages available that can be obtained with either the AM or SSB mode of operation. The great drawbacks of AM (like random noise, ignition noise and co-channel interference), are practically absent with the NBFM mode. With AM, an interfering signal on the same channel may require an input signal to 20 to 35 dB above the interfering signal for an acceptable S/N ratio, while the FM mode requires only 6 dB or two times the signal strength of the interfering signal, because the FM receiver responds to frequency variations and limits amplitude variations caused by noise or other unwanted signals. Again, let us remind the reader that the described advantages are *not* obtainable with the use of slope detection.

Unfortunately, very little information on NBFM has appeared in print recently, at least not in print available to the average amateur and many of the younger amateurs in age and term of license are, in the writers opinion, convinced that the FM mode of operation went out of use with the cats whisker and crystal set era. Many do not realize that Governmental Agencies, Armed Forces Services, Business Band Operators and not to forget the big Commercial Tropo Scatter Stations, where reliability is a prime requisite; *all of them* use FM.

Some time ago the writer ran across an advertisement of a prominent manufacturer of amateur and business band gear who had this to say about his new line of NBFM transceivers, Quote, "rugged, with capture effect reception, overcomes interference, immunity to ignition noise" and here comes the punch line "The FM mode results in greater range than AM units." Interesting, . . . when it comes from an outfit that lays it's cash on the line.

The readers who are still with us, even those who may disagree with us, may find a few interesting points in our closing lines. Amateurs, for example, living in an apartment house in greater New York City, operating six and two meter AM phone, have, at one time or another, had their share of

"Indian" warfare, although their transmitter like ours was perfectly clean. Demonstrating an interference free TV receiver operating in the shadow of the transmitting antenna means absolutely nothing to a person having TVI and who does not want to be helped. Explanations, advice, and even the offer of a free $4.00 high pass filter makes no impression.

I have listened to many six meter heroes shouting their battle cry of "co-operate *but* operate." With few exceptions they moved up to two meters or wound up with self imposed silent hours when the "Indian" pressure become too great. We are lucky to hear them working the midnight shift now-a-days.

The writer and a group of fellow amateurs decided some four years ago to avoid all this aggravation on six meters and "switched rather than fight" to the NBFM mode of operation and all in our group are now operating our six and two meter rigs any day, any hour with no TVI complaints whatsoever. Since possibly the majority of TVI complaints are of the audio rectification type, that's where they copy your call and location, as it was in our case, switching to NBFM eliminated all further complaints.

It is true, our maximum power into the antenna is only 40 watts. It is likewise true that our transmitting antenna sits right in the middle of a forest of TV antennas on top of a six story building housing 67 families. Some of our fellow amateurs run their NBFM modified Zeus transmitters at 180 with no TVI complaints, while operating the same transmitter on AM practically causes an uprising in their immediate neighborhood. While FM has many advantages, it can not perform miracles and in the case where TVI is caused by the transmitter's carrier, resulting in a severe front-end overload at the TV receiver, there is nothing that NBFM can do to eliminate this condition, at least not at the transmitter, because FM like AM does have a carrier. However, where modulation bars on the TV screen and audible interference are the complaints, NBFM will resolve these complaints, almost 100 percent, in practically all cases.

We would like to conclude with the following: if going NBFM eliminates or at least greatly reduces certain types of TVI, then that feature alone recommends it's use, *especially,* if in doing so, *peace* is restored on the *"reservation."* . . . WB2CPG

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Transmitter Keying—with Transistors

The most common method of keying a CW transmitter is the simple operation of opening and closing the cathode return circuit(s) of one or more stages in the transmitter. This mode of operation is effective, but it turns out to be uncomfortable, if not downright dangerous, due to the high dc voltage which appears across the terminals of the key. The problem is often solved by the use of a keying relay. It is also possible to accomplish cathode keying by the use of a transistor (or transistors).

What are the requirements for a transistor to do this switching job? First, it should be an NPN transistor so that it can be used with the positive collector voltage that appears at the cathode of the tube circuit which is to be keyed. Second, it should be capable of withstanding the open-circuit cathode voltage from collector to emitter (V_{ceo}) during key-up conditions. And third, it should be capable of carrying the plate current of the keyed stage continuously during the key down condition.

In the early days of transistors, their voltage ratings were severely limited, and it was rare (and expensive) to find one with a V_{ceo} rating above 100 volts. More recently, several manufacturers have announced units with voltage ratings in the 300 to 400 volt region. These same transistors will handle currents of 100 ma or more and have collector dissipation ratings in excess of 1 watt. The RCA 40264 has a V_{ceo} of 300 volts, a maximum collector current rating of 100 mA collector dissipation of 1 watt and sells for $1.21.

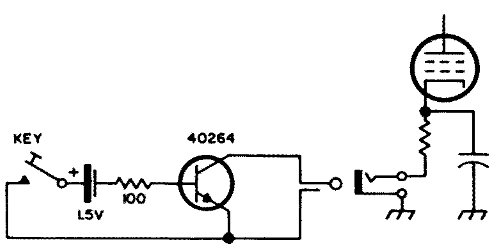


Fig. 1. The simple keying circuit.

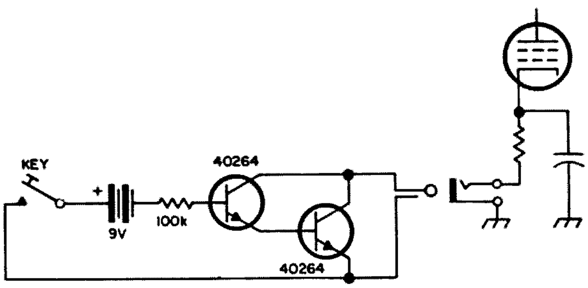


Fig. 2. The Darlington circuit further reduces battery current drain.

During key down conditions, the switching transistor will be operating at high currents, but the terminal voltage will be very low so that the collector power dissipation will be less than half a watt. In addition to keeping the power dissipation low, this low collector voltage during key down conditions minimizes the effect on the bias voltage for the keyed stage of the transmitter. The saturation voltage under these operating conditions should be less than 5 volts.

The keying circuit turns out to be very simple in practice—**Fig. 1.** The bias battery voltage and associated resister are selected to cause the keyer transistor to draw saturation current under key down conditions. Current drain from the bias battery can be further reduced by using the Darlington circuit shown in **Fig. 2.** Both transistors in the Darlington circuit must be capable of withstanding the open circuit cathode voltage of the transmitter. In checking your transmitter, make sure that you use a high impedance voltmeter (preferably a VTVM) when measuring the key up voltage.

As a typical example, the Seneca transmitter shows 250 volts across the open key contacts, and it draws 90 mA when the key is closed. An RCA 40264 transistor was used in the keying circuit shown in **Fig. 1.** A 1½ volt battery and a 100 ohm resister

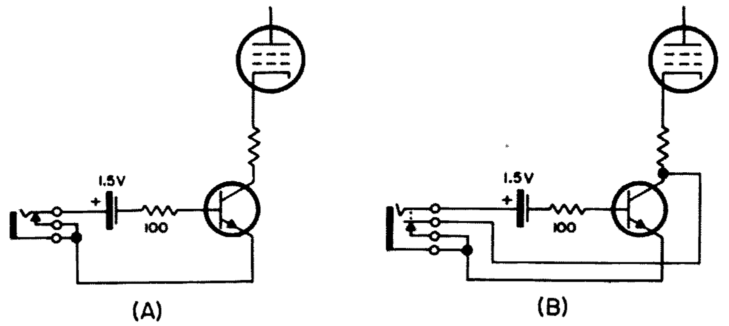


Fig. 3. Replacement key jack which has a separate pair of switch contacts which close when the key plug is withdrawn.

draw 4 mA at the base of the transistor and this is sufficient to drop the collector voltage from 250 volts (key up) to 3 volts with the key closed. The same transmitter was used in the circuit of **Fig. 2** with a 9 volt transistor radio battery and a 100,000 ohm resister. For these conditions, the base current is 70 microamps and the collector voltage drops to 2 volts with the key down. Take your pick.

A transistor keying circuit can be built into the transmitter as an installed modification. When doing this, the keying jack should be replaced. Most keying circuits use a jack which has a grounding contact to short out the keyed circuit when the key plug is pulled out. This type of jack, **Fig. 3A**, will work with the transistor keyer, but it will leave the battery connected and drawing current continuously. It is recommended that the regular key jack be replaced by one which has a separate pair of switch contacts that close when the key plug is withdrawn. **(Fig. 3B)**.

As an alternative to modifying the transmitter, the transistor keyer circuit can be built into the key, or into a small unit which can be plugged into the normal key jack of the transmitter. The key can then be plugged into this sub-assembly to key the transmitter. These unit arrangements external to the transmitter have the advantage that they can be used with other transmitters as long as the voltage and current ratings of the keyer are not exceeded.

The circuits shown in **Fig. 1** and **2** are great, if the cathode voltage does not go higher than the voltage rating of the available transistors. The circuit of **Fig. 4** is a variation which can be used to increase the maximum voltage level which can be keyed. In this circuit, the voltage applied to the keyer transistors is divided across the series string by the resistive divider in the collector circuit. A similar resistor divider is connected in the base circuit to bias the upper transistors off during the key up condition. The supply for this divider should be the B+ for the keyed stage and the tap voltages should be just slightly lower than the corresponding emitter voltages. The resister in series with each base should be set to limit the base current to the level required for saturation (about 3 to 5 mA) when the key is closed.

Several transistors can be used in series to key 1000 volts or more. There would be no trick in keying your final amplifier with this arrangement, but remember that the transistors must be rated to carry the total key down current of the keyed stage.

It is also possible to combine a sidetone keying monitor with a transistor to key the cathode circuit of a transmitter. An audio oscillator may be keyed, the output tone rectified, and the resulting dc signal used to provide the base drive for a keyer transistor. **Fig. 5.** This circuit also lends itself to use with tape recorded signals. The recorded information can be played directly into the tone rectifier for keying the transmitter.

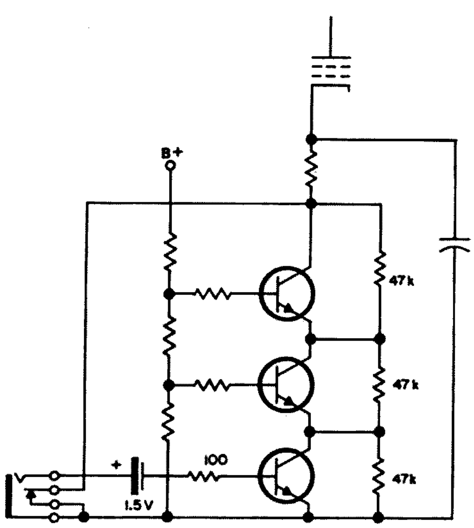


Fig. 4. A variation of circuits shown in Figs. 1 and 2.

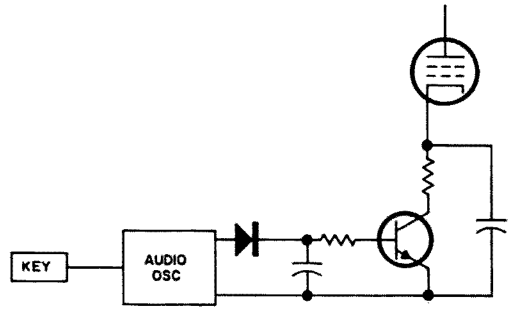
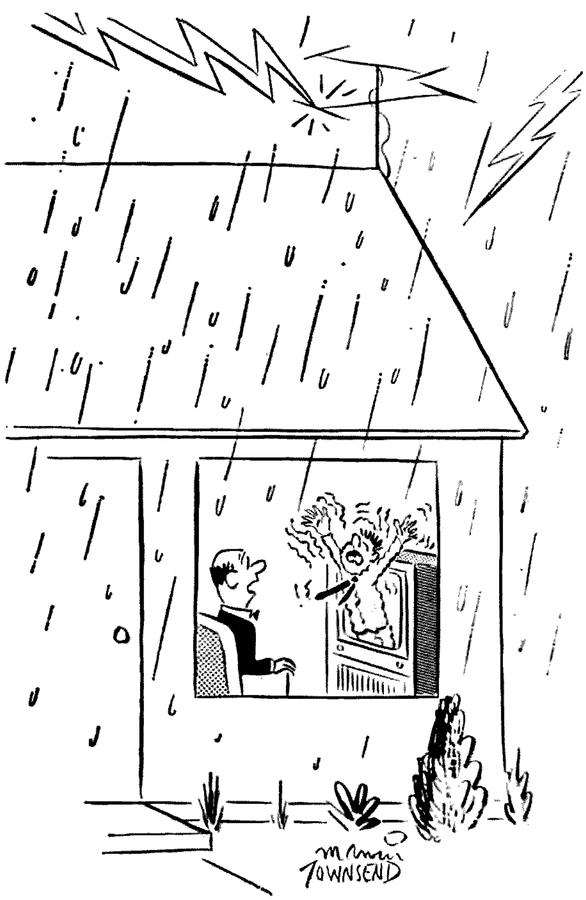


Fig. 5. Keying an audio oscillator to provide drive for a keyer transistor.

One caution with applying transistorized transmitter keying. Make sure that your transmitter is keyed to the cathode circuit. If your transmitter has blocked-grid keying, the keying voltage will be negative and you could lose a transistor in a hurry if you plug an NPN transistor into it. If you want to transistorize the keying with a blocked-grid keyer you will have to adapt these circuits to the use of PNP transistors.

If your transmitter is cathode keyed, then here is your cure for that nippy key and the sparking contacts.

. . . W6HEK



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Mini-Mitter; The Ultimate in Miniatures!

World's smallest HF Transmitter?

Well, maybe not *the* smallest but a pretty darned good runner-up! Now that we've apparently succeeded in 'mini-mizing' everything else from automobiles to skirts and now to electronic components, maybe it's time we tossed a few minis together into a compact 'talk-box'. The "Mini-mitter" does just that; a completely self-contained CW transmitter with integral power supply, all housed in a 2" x 2" x 2½" minibox . . . much less than half the size of the popular walkie-talkie. And, is "Mini-mitter" limited to a range of a few city blocks? Not by a long shot; her debut was made her first day on the air by chalking up a 300-mile contact in broad daylight with a readable signal reported! And she's been behaving just as well ever since.

Her 'heart' is an OX crystal oscillator recently introduced by the International Crystal Manufacturing Company. This little gadget, with all components and a beautiful little etched circuit board only 1½ inches square, is sold as a kit for a mere $2.35 postpaid! Everything is included; transistor and socket, crystal socket, all resistors and capacitors and the specially-built inductance. Mounting screws, spacers, nuts and lock washers . . . they're all there! All it takes to get on the air is the 20 to 30 minutes to put it together plus a key, a 6- or 9-volt battery and a crystal of whatever frequency you choose between 3000 and 6000 kHz. Use your own crystal, or preferably, one of International's EX crystals around which this oscillator was designed—just a few pennies more from your piggy bank. If you use your own rock you may have to whip up a little adapter if your crystal pins and spacing vary from the socket provided; this is no trick however—ten minutes will do it.

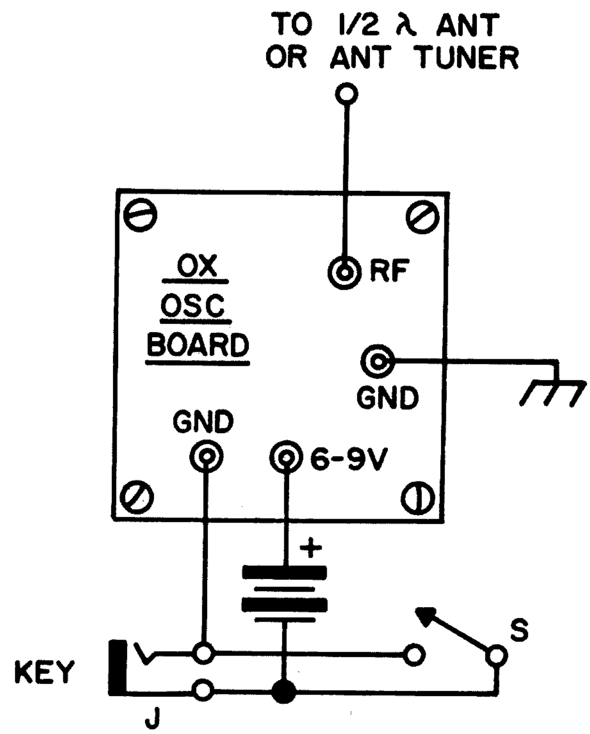
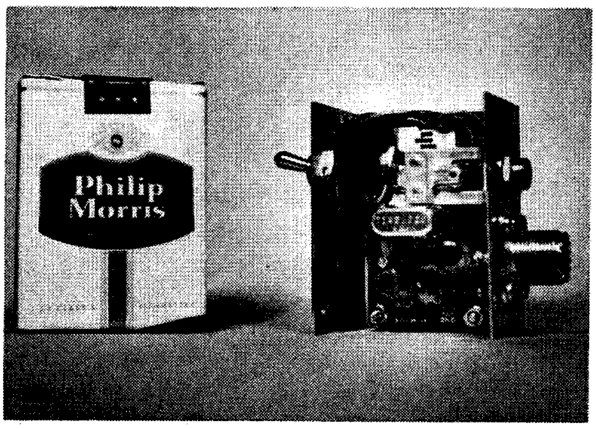


Fig. 1. External connections to the International Crystal OX oscillator for operation as a low-power transmitter.



Mini-Mitter proudly exposes her innards.

Aside from the little oscillator assembly, we have added a coax connector (use a phono plug if you prefer), key jack and a SPST toggle switch. This latter may be omitted if you like; it is simply connected across the key and serves to keep the circuit oscillating should you want both hands free to set spot

DB—A Curious Animal

One of the most talked about, and least understood, facts of radio, is that of dB gain. Below is a simple table of dB vs Power Gain

Decibels	Power Gain
1	1.26
2	1.58
3	1.99
4	2.51
5	3.16
6	3.98
7	5.01
8	6.31
9	7.94
10	10.00
11	12.60
12	15.80
13	19.90
14	25.10
15	31.60

Now lets say that you have an antenna with 6 dB gain, and by increasing the size one way or another, you eke out one more dB. By looking at the table, you have increased from 3.98 to 5.01 power gain which figures out to be an increase of 26 percent.

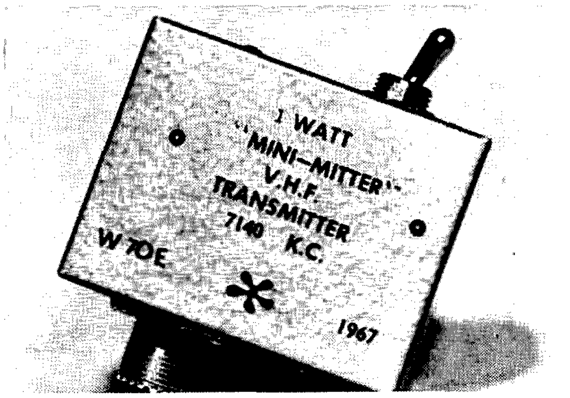
Carrying this further, if you raised a 13 dB antenna to 14 dB gain, you would increase 19.90 to 25.10, or 26 percent mathematically. But, assuming you have 100 watts at the antenna, increasing from 6 to 7 dB would raise your theoretical antenna power from 3.98 to 5.01 times 100 watts, or 398 watts to 501 watts; an increase of 103 watts.

Now lets take the other instance—we have raised the power from 19.90 to 25.10 watts—or an equivalent of 1990 watts to 2510 watts. This time you have gained 520 watts. Obviously while the 103 watts is not to be taken lightly, it is obvious that when you get into the high gain antennas, squeezing out one more dB is a very much worth while thing.

You can immediately see that stacking an antenna with a gain of 10 dB you would, as they say, "double the power" (or from the table increase it 1.99 times). This would become 19.9 against 10.0. You have increased your 100 watts to an equavalent of 199 watts (assuming no stacking loss).

A stacked antenna certainly is cheaper than doubling your transmitter power.

W. Roberts W9HOV



Completely self contained, including power supply, the "Mini-Mitter" can be nestled in the palm of your hand!

frequency on your receiver for example. As this is an untuned circuit, no tuning controls are provided or required; to change frequencies, simply plug in the appropriate crystal and you've got it made . . . what could be simpler?

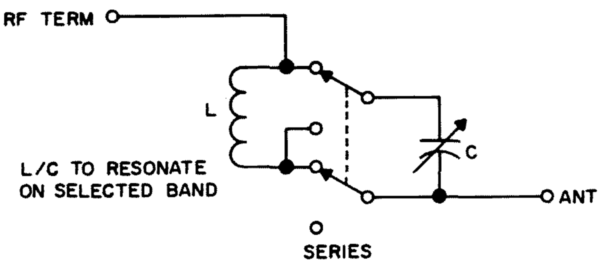
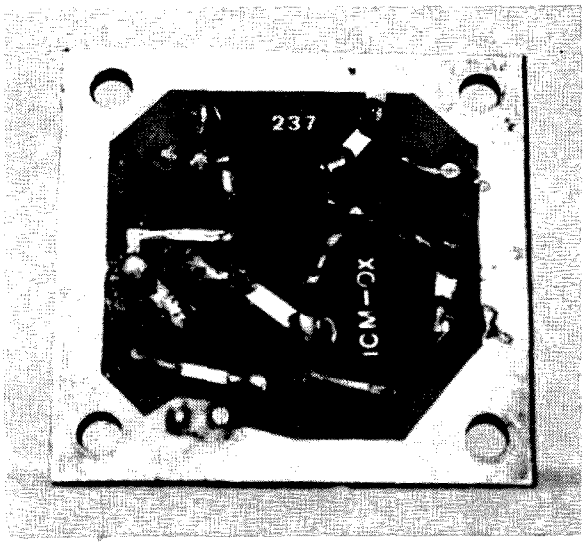


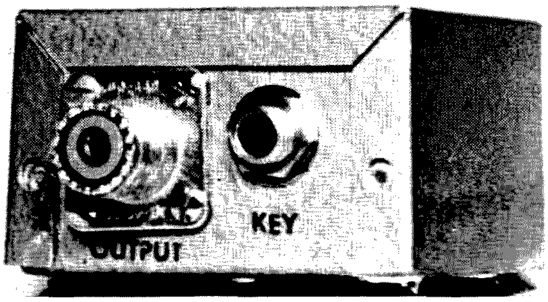
Fig. 2. An auxiliary antenna tuner for loading the mini-mitter into a random length wire. The L/C ratio is selected to resonate on the desired band.

With only milliwatts output, a *good* antenna is a *must* if you hope to work reasonable distances. If you have a half-wave dipole or equivalent frequency conscious antenna, simply plug the coax feeder from the antenna into the connector on the "Mini-mitter" . . . no trick antenna tuners or other gadgets to bleed off energy. However, if you propose to use the little rig with a random length wire for portable operation, for instance, you *may* have to rig up a 'minituner' for it. This too, is no trick; you can get a suitable coil and variable capacitor in a matching 'Mini-box' and a conventional L/C circuit will fill the bill. Should you want to go whole hog, add a DPDT toggle switch to change the antenna capacitor to 'series' or 'parallel' as desired. Such a tuner is shown in the schematic which, together with the "Mini-mitter" will give you a very flexible antenna choice. Assembly instructions and schematic for the oscillator board accompany the kit so we are simply showing the



Underside of the printed circuit board on which all components were installed in twenty minutes!

connections which are *external* to the board. The terminals are plainly marked as shown.



The only external connections required are to the antenna and key!

While this little oscillator was designed and built by International with apparently no thought of its communication capabilities, but more as a test oscillator, it occurred to us to hook it to a sky wire on a hunch. We were dumbfounded! Is 300 miles on 40 meters with 1.2 watts inputs bad? This, with a six volt battery; in the final assembly we found that we could just squeeze in an RCA #VS323 9-volt transistor battery (or equivalent) which raised the input power to 1.8 watts.

Drop a small handful of nickels and dimes into this little project and put it on the air. It will surprise and amaze you and you'll have no end of fun!

. . . W7OE

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Receiver Front End Protection

The first transistor in a radio receiver is very likely to take too much overload voltage when a medium or high powered transmitter is being used. Back-to-back diodes connected across the coaxial input jack to the receiver or converter offer considerable protection, but still enough signal gets through to sometimes cause a deterioration of the first transistor and an increase of noise figure. Ordinary 1N100 low forward resistance germanium diodes seem to be desirable for this back-to-back connection. This type has very low shunt capacitance and can be used up through 432 MHz.

One quick way to damage a transistor, or even a tube front end, is to use antenna and power relay switching without a timed sequence system. If the power relay turns the transmitter on before the antenna relay transfers the antenna to the transmitter, this is bad! Even worse, if the antenna relay switches to receive at the same time as the power relay turns off, arcing will occur and the receiver gets a terrible voltage input surge.

The power supplies have capacitors and filter chokes which tend to keep some voltage on the transmitter tubes for a short period after the ac line is opened. This produces rf output and an arc in the antenna relay contacts as it switches from transmit to receive, unless this relay operation is delayed a fraction of a second. It is also better to have the reverse take place when switching to transmit. This procedure is called timed-sequence relay switching. It can be accomplished by using a dc supply for the relays through power diodes and RC networks. One form is shown in **Fig. 1**, which someone developed quite a few years ago. It has been in service at W6AJF/AF6AJF for several years, dating back to 6J6 rf tube failures with high powered 144 MHz transmitters.

From time to time a check is made on the capacitance of the electrolytic capacitors because the values shown in **Fig. 1** are near the minimum permissible for good protection. The 10-watt resistors get pretty warm and these were finally mounted outboard from the main small chassis in order to not affect the electrolytic capacitors. A recent change was the addition of a double-pole toggle switch S, in **Fig. 1.** This permits the use of a 200 mA field antenna relay which had superior isolation characteristics at 432 MHz. Regular "115V ac" relays usually require about 100 mA at 50 volts from a dc supply, so the main components were chosen for these types of power and antenna relays. A small 50 volt, 15 mA relay was added to the circuit years ago for receiver muting purposes, so there are three main branches fed from the 120 volt dc supply in **Fig. 1.** Each branch operates in the proper sequence due to the power diodes, resistors and capacitors in each relay circuit.

If one operates in the VHF or UHF regions, antenna relay feed-thru can be a major headache. Some types of coaxial relays do not offer enough isolation between the contacts as the frequency goes up. A relay that is satisfactory at 7 or 14 MHz may be pretty poor at 144, and dreadful at 432 MHz. An old relay that has gotten out of proper alignment can be a lethal device for a transistor receiver. Even some new relays are not suitable for VHF service. Any antenna relay should have more than 60 dB of attenuation between the send and receive positions. If a person operates at full legal power, the antenna relay had better be of the 70 to 80 dB isolation type at the frequency of operation. Some relays have a very low SWR rating into the UHF regions but lack enough isolation attenuation to protect a receiver. The poor back-to-back diodes in the receiver front are then taxed beyond their protective capabilities and the

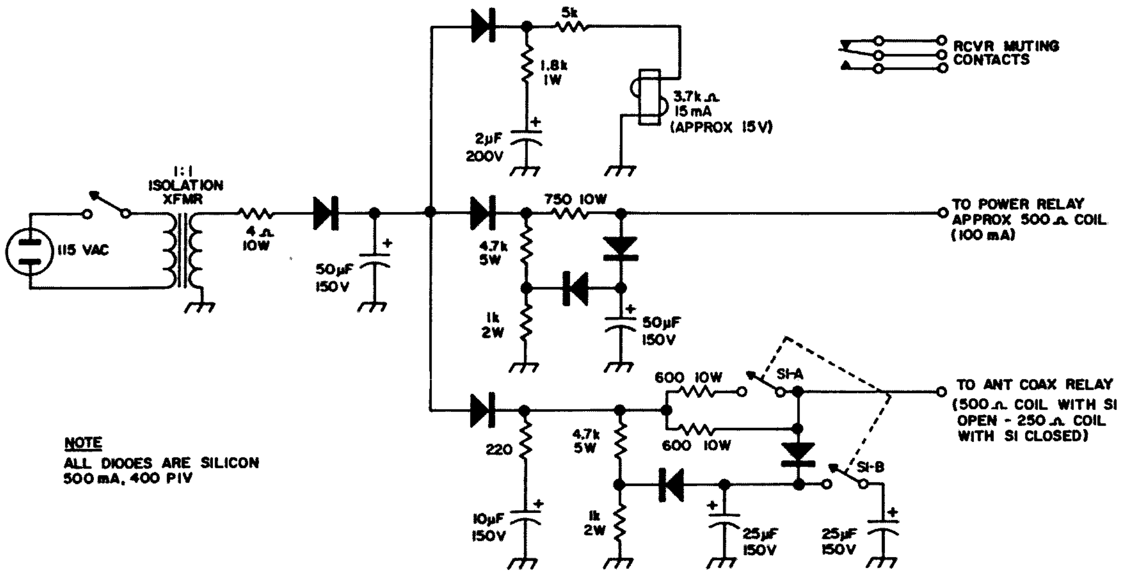

Fig. 1. Timed sequence relay switching system.

front end transistor may develop a poor noise figure. Weak signal reception then becomes a thing of the past and local contacts are all that are left.

At least five coaxial relays are in service at W6AJF for different bands of operation up thru 432 MHz. The writer finally got around to making some attenuation tests since some of these relays had been used for 10 to 15 years. The results were pretty horrifying in some cases and a program of adjustment and relay replacement was undertaken.

The method of relay testing was to connect a signal generator to the "antenna" side of the relay and a 50 ohm termination to the "transmitter" connector. The receiver was connected to the "receiver" side. The signal generators available had good calibrated attenuators in terms of microvolts from 1. to 100,000. Additional 20 dB coaxial attenuators (10 to 1 voltage attenuation) were available for checks on the generator attenuator accuracy at each frequency. The microvolt reading direct thru the relay into the receiver was then set to give a reference S-meter reading, such as 2 microvolts for an S6 reading. The relay was then energized to the "transmit" position and the signal generator output increased until the same S6 reading was obtained. If the generator read 200 microvolts, the relay has 40 dB of attenuation or isolation. 2000 microvolts would mean 60 dB and 20,000 would be 80 dB. The accuracy depends upon the receiver or converter input impedance which should be 50 ohms. Since most receivers have a better signal-to-noise ratio if somewhat mismatched, a 6 dB pad was connected in series with the coax lead to the receiver front end. The receiver was being used only as a sensitive rf voltmeter with no calibration being necessary except for a constant S-meter reading.

If E_1 is the direct input microvolt reading and E_2 is the second reading with the relay energized to the transmit position, then $dB = 20 \log E_2/E_1$. If the signal generator has its attenuator calibrated in dB, then no slide rule work is needed, only the subtraction of one reading from the other.

Tests were made on a number of relays over the range of from 28 to 432 MHz. If the relay showed at least 60 dB isolation for the band it was operating in, and the transmitter power input was normally less than 500 watts, it was left in service. For the 500 to 1000 watt transmitters, no relay with less than 70 dB isolation was left in service.

The isolation readings obtained at first are listed below for 432 MHz. It was found that the Dow-key relays could be adjusted for contact spacing by loosening the lock nuts on the transmitter and receiver coax fittings and rotating the fittings in or out of the relay case. These adjustments seemed to be very critical, since too large a gap prevented contact and too small a gap pre-

vented the Dow leaf shield inside the relay from functioning as an isolation shield.

Advance relay #1 = 28 dB
Advance relay #2 = 43 dB
Dow relay #1 = 55 dB
Dow relay #2 = 31 dB
Dow relay #3 = 26 dB

Small FEC #CS300 (100 watt relay) = 66 dB

Transco relay (type N fittings) = 75 dB

The two Advance relays were of different types and were not suitable for 432 MHz. They were retired to the "dc" bands below 30 MHz. The Dow-key relays were carefully adjusted and provided 75, 65 and 75 dB isolation respectively at 432 MHz. This isolation was sufficient at 432 MHz, but due to the UHF fittings versus "N" fittings, the SWR was not as good as with the Transco relay. The latter appeared to be better mechanically and not subject to maladjustment.

Next, tests were made at other frequencies with some of the results listed here:

220 MHz

Dow #1 = 70 dB
Dow #2 = 66 dB
Dow #3 = 75 dB

144 MHz

Dow #1 = 78 dB

50 MHz

Advance #1 = 44 dB
Advance #2 = 71 dB

28 MHz

Advance #1 = 60 dB

432 MHz

Large old *radar* relay with type N fittings = 40 dB

An example or two of voltages to be expected with 60 dB isolation will be given. Take a high powered SSB signal of 2kW PEP with perhaps 1400 watts peak output. If the antenna is 50 ohms at the antenna relay, $E^2 = RP = 50 \times 1400 = 70{,}000$. E = 264 volts at the relay contacts. Therefore, 264/1000 = 0.264 volts at the receiver contacts for 60 dB isolation; 264/3150 = 0.084 volts for 70 dB isolation. The latter would impose no strain on the front end of the receiver, but the first case would be marginal.

A 100 watt AM signal input might have a 200 watt peak output; therefore, from above, 50 x 200 = 10,000; E = 10000 = 100 volts.

100/1000 for 60 db isolation = 0.1 volt across receiver which would be a safe value. With other than 1:1 SWR, the voltages could be higher or lower.

The back-to-back diodes are mainly for protection in case of large static discharges across a lightning arrestor from a nearby thunder storm. These diodes on the receiver input will reduce several volts of rf from ¼ to ½ volt, thus reducing the number of replacements of transistors which might be inconvenient, time consuming, and expensive. A good antenna relay, with lots of isolation between transmit and receive, is the best insurance against transmitter overloading of the receiver. Timed sequence relay switching not only stops antenna relay arcing and point wear, but eliminates tremendous peak voltages from getting into the receiver. All three forms of protection should be used, especially with transistor converters or receivers.

. . . W6AJF

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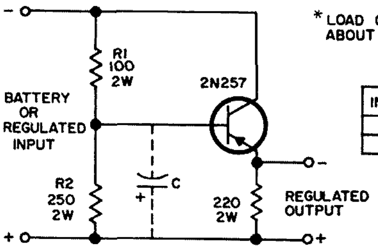
A Regulated DC Voltage Divider

A means of reducing a regulated or storage battery source of voltage while maintaining good regulation.

Many of the integrated circuit units on the market are designed for 3.6 or 6 volt operation. Transistor circuits of the "old" type are generally designed around somewhat higher voltages and therefore existing supplies often do not go down to the IC voltages. Current requirements of the IC's are rather high and variable and in most cases do not allow the use of dropping resistors or voltage dividers. A J-K flip-flop IC will draw 25 mA or so and if you want to divide by ten, you use four of these at around 100 mA. A crystal oscillator and buffer plus a Schmitt trigger to drive the flip-flops will raise the current some more. So it's not unusual to need a couple of hundred milliamps at 3.6 V.

The unit described here will permit the use of an existing regulated and filtered supply or storage battery to furnish voltage for these units. Furthermore, it can supply additional filtering if needed by adding a filter capacitor where it does lots of good.

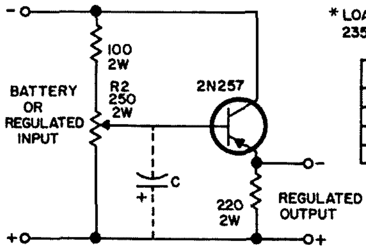
In the circuits shown, R1 and R2 constitute a voltage divider across an already regulated source. If they are chosen so that the current through them is high compared to the current needs of the base of the transistor, then variations in the base current will cause only small variations in the voltage at the junction of the resistors. Thus this voltage can be used as a reference for the standard voltage regulator circuit which



* LOAD ON 7.6V SUPPLY ABOUT 235 mA

INPUT V	OUTPUT mA	OUTPUT V
7.6	0	3.8
7.6	*180	3.6

Fig. 1. Circuit for regulated DC voltage divider.



* LOAD ON 12.6V SUPPLY 235 TO 245 mA

INPUT V	OUTPUT mA	OUTPUT V
12.6	0	6.1
12.6	*180	6.0
12.6	0	3.8
12.6	*180	3.6

Fig. 2. Circuit used if the input is from a fixed source such as a storage battery.

describes the rest of the circuit. If the input voltage is from a variable source, the output voltage can be varied by the existing voltage control. If the input is from a fixed source, such as a storage battery, the circuit of **Fig. 2** can be used and R2 will vary the output voltage. R1 in this case limits the voltage. In practice, if the current through R1 and R2 is 30 to 40 mA, and the maximum base current of the transistor about 2 mA, then adequate regulation will result. The transistor can be any audio output PNP device of two watts or more at 40 volts collector to base rating such as the 2N257. For higher voltage drops and currents which result in more transistor dissipation, a unit such as the 2N441 or 2N442 will work nicely in the circuit. The transistors should have adequate heat-sinks and resistors of good quality and ratings of two watts or more should be used so that a breakdown and change in output voltage will not damage the IC's.

An electrolytic filter capacitor connected as shown will increase the filtering if needed. The more capacity, the better at a voltage rating about that of the input supply. The effect of capacity at this point is amplified by the transistor and a 100 μf or so will have the effect of many hundreds of μf across the output.

. . . W5NPD

Gay E. Milius, Jr. W4NJF
421 Saddle Rock Rd.
Norfolk, Virginia 23502

The QSL Manager

My Postman came to the door the other day to ask why I suddenly became so popular that he was having to carry an extra load addressed to me. He remembered when I impatiently waited for him, looking for the occasional foreign envelope or card. Now, I was swamped with them—or he was. How could I explain to him that I had taken on the QSL chores for several rare DX stations? And then not long ago I was asked on the air what advantage did a QSL manager offer to a DX station? The questioner apparently had just started chasing DX, but I could frame an explanation for him far easier than to my postman.

A QSL manager at the outset gives a DX station more time to operate by relieving him of the arduous task of answering hundreds of QSLs. A QSL manager also saves money for many US and other amateurs by saving them expensive airmail charges connected with sending a card or envelope to, and getting a reply from some spot on the globe where mail may be delivered only once a month. It also speeds up delivery of QSL cards to those who impatiently want them for certain awards.

The job of a QSL manager—in my opinion and not that of very many other people—is quite interesting. I enjoy handling piles of QSLs for the same reason that I enjoy trimming the hedge around my house, although the neighbors think I am "Nuts". Perhaps I am. I said it!

I can always say that I took up QSL managering because of my ultruistic attitude: I have received so many cards from various other managers that I believed I should return the favor. Maybe that is true, but on the other hand I was interested in learning first hand what a QSL manager received, the different comments on the cards, what a DX log looked like, and I must admit it does sound good to hear a rare DX station tell the world to QSL via W4NJF. Only my postman suffers.

They ask how do you get started in this business? Of course, the first thing is to hook up with a DX station and make arrangements with him either by mail or on the air. Usually the DX station is one to whom you speak frequently or one to whom you have a consistently good signal so that you can maintain a regular schedule with him. He must also want a manager, as many prefer to QSL personally. It is also advantageous to have a working contact with a QSL printer whereby you can have QSLs printed at reasonable cost and within a short time. If you have to wait around for a printer to produce you can get all fouled up. Then there are financial arrangements to complete. If the QSL manager is going to do all the work he shouldn't be obliged to foot the bill as well. DX stations realize this and make elaborate preparations to reimburse expenditures. However, it is difficult to obtain US dollars in foreign countries and it can be complicated.

When you have set up the arrangements with your DX friend, and you are definitely engaged as QSL manager, you can drop a postal card to the various publications which print DX information, including QST. (Rod Newkirk), *CQ* (John Attaway), *DX Magazine* (Gus Browning), and any others you can think of. However, certain of the weekly bulletins do not want QSL manager information and I have been informed of that in no uncertain terms. Hence there is no need wasting postage in that direction. Nevertheless, when your man gets on the air, anybody interested will hear him announce your call as his manager. You'll get no better publicity.

There is one item which is rather important in making the announcement of your appointment. Be certain to state the date on which your tenure commences, the date after which you will accept cards. If you do not do so, you will receive a bundle of mail for past QSOs for which you will have

no logs. If it has been cleared with your principle it will also be essential for you to include in your announcements that every card must be accompanied by a self-addressed stamped envelope (sase) or International Reply Coupons (IRC) as this venture is not a philanthropic one. Many uniformed amateurs, used to exchanging cards with US stations only, merely send you a card asking for one in return. Naturally, the QSL manager does not have funds to reply to all comers when the tally can amount to thousands of QSLs. So, be specific if your DX friend directs you to answer only cards with proper return postage. Of course, if he wants to do otherwise and will reimburse you, then that is a different question.

Once your call is promulgated it is not long before the postman arrives laden with correspondence. At this stage all you can do is to arrange the cards in their return envelopes in date/time order as you patiently await the logs. I have been successful in circumventing this waiting, knowing that many DXers are impatient for their cards. I QSO my DX stations and confirm their cards over the air one by one. I also, when I have time enough, and can hear him, monitor his QSOs and log them myself. This saves time and prevents a large stack of cards from accumulating.

Finally along come his logs. Then I suggest that you obtain a large mailing manila envelope (11½" X 8"½) in which to store them and the cards awaiting reply.

Mark the envelope plainly on the flap with a red marker pencil. (This way you can see it from top as well as sides.) Next you can devise your own method of checking each call in the log after you have sent out the corresponding card. I always put "X" after the station call to indicate that it has been answered. I use a red ball-point pen and make another X in the upper right corner of the card which has been answered. Then I file all the answered cards in a shoe box.

You will discover that despite your admonitions many amateurs continue to send QSLs without SASE etc. Many QSL managers have told me they merely consign those to the circular file. I try to answer them by sending the reply through a bureau—stacking them for months until I have enough to send them along third class mail. It costs only 4 cents with open envelope to send 2 ounces of cards to US bureaus and to overseas stations it costs 6 cents for the same weight. I can get about 14 cards in a regular envelope at these prices. (I always admonish senders not to send a QSL manager cards without sase.)

Another problem is replying to SWL cards. This depends upon the policy of your DX station. He may not care for you to use cards or time to reply to SWLs or he may want specific information before sending a card. Many SWLs drop a card in the mail saying "I heard you on such and such a date—such and such a time and you were 59 working W4XXX." This is all right but it is absolutely useless to the DX station and is hardly an indication that he heard the DX station or just the W working the DX station. So I have a habit of procrastinating my reply to the SWL cards until I have no other cards to handle. Then I start seeing if their information fits the logs.

Most real DXers know how to make out a card and do so correctly. It is the newcomers who cause the trouble. They neglect to use GMT, they get the date a day or so off, they write so poorly that I can not make out their information.

There is one thing I think should be emphasized when it comes to QSLs. I am against QSL cards with the information I need on the reverse side. I strongly feel that ALL information should be on the front of the card. However, if this is impossible then the senders should at least have his call on the reverse side with the other information.

Imagine yourself with logs piled in front of you and cards stacked beside you trying to find a call somewhere in the logs. The time and date is on the back of the fellow's card but you have to reverse the card to find the call sign. Then you have to go back to the reverse side and get the information. Furthermore, cards with information on the reverse side must be mailed only when they are inserted in an envelope because nine times out of ten the postmark obliterates the information which is needed most. The post office can not fail to mess it up because of the size of the standard cancellation.

Hints for the QSL sender: always put your call letters on the front of the return envelope, put the QSL manager's address in the upper left corner of the return envelope, and remember to put on the cover envelope the station's call for which the enclosed QSL is sent. A QSL manager with

several DX stations in his "farm" can sort the mail much easier in this fashion.

More Notes: I wonder how many people realize that IRCs can be exchanged between hams like "due bills?" Every day I receive IRCs which have travelled across the seas several times. However, U.S. IRCs are only good to DX stations and can only be used here to send to DX stations themselves for their QSLs. They can be sold, of course, to other amateurs in the U.S. under their face value if the QSL manager has a large pile of them. At the post office, foreign IRCs (except those of Mexico and Canada) can be exchanged for 13 cents worth of stamps. Thus they are worth a great deal of money when you obtain a sufficient number. If you have any Mexican or Canadian IRCs send them out of U.S. The odd value of airmail postage accounts for the QSL manager receiving extra IRCs; airmail to Europe is 20c per ½ ounce so it takes 2 IRCs to cover that, but at the post office you can receive in return 6c worth of stamps; other places where postage is 25c per ½ ounce IRCs will cover the expense but will return only 1c. I usually use the extra stamps to pay for overseas cards which come without IRCs or to pay for postage to send cards to the various bureaus around the world. Which brings up another point. This country has NO outgoing QSL bureau. The ARRL is looking into the feasibility of setting up such a thing. Accordingly, it costs quite a bit of money to send envelopes to the many countries which have their own bureaus. Private QSL bureaus are operating but that expense is too great when at present one can send about 14 cards to a foreign QSL bureau for 6 cents if the envelope is left open and marked "Printed Matter Only". The hams in the Norfolk area have been meeting every month to pool their cards going to the world bureaus.

One other bit of information to have when you become QSL Manager is that your own QSL bureau here in the U.S. will receive a flood of cards for your DX station addressed via your call. You must expect this and let your bureau know, so that they understand where to send the cards. You must also furnish your bureau with extra envelopes because the volume mounts up ferociously. It is the reply to cards received through your bureau that makes up the best part of the volume you will have to send out through the world bureaus.

In conclusion, when your DX station finally leaves his DX location and closes down, you will still receive cards for him. I have been receiving for one station as far back as two years. I do not know what goes on in the ham's mind but some move very slowly. Therefore, be sure to retain the logs or Xerox them before you send them back to the operator.

. . . W4NJF

19th Annual DX Club Meeting in California

The Southern California DX Club wishes to announce that the Nineteenth annual joint meeting of the Northern and Southern California DX Clubs will be held on the 27th and 28th of January, 1968 at the Del Webb Towne House in Fresno, California. In recent years the joint meeting of our two clubs has blossomed into *the* yearly West Coast DX Convention. Last year's attendance of 200 included most of the prominent DX'ers on the West Coast, many distinguished visitors from the East, and a top line of guest speakers and convention events.

As sponsors of this years event, the Southern California DX Club extends a cordial invitation to all DXers to attend the January 27-28 meeting this year.

All room reservations should be made directly with the Del Webb Towne House, Tulare St., Fresno, California. The convention will start at 12 noon on Saturday, and will end at 12 noon on Sunday. Further notices on the availability of tickets, preregistration, etc., will be mailed in mid December to members of West Coast DX clubs for which a mailing list is available. All interested individuals throughout the country may obtain such a notice upon request. Further inquiries should be addressed to:

W6AOA Frank Cuevas
General Convention Chairman
14919 Yukon Ave.
Hawthorne, Calif.
90250

or

Larry Brockman WA6EPQ
Publicity Chairman
30927 Rue Valois
Palos Verdes Penn., Calif.
90274

Fred R. Herr W3WPV
330 Vintage Way
Pittsburgh, Pa. 15232

160 Meter Flat Top

Not all of us are blessed with large, rambling estates. In fact, most of us are short on real estate and do not have room to erect a full size antenna. This was my problem at one time, and I believe many more hams are faced with the same perplexity. This article describes a long antenna for use on a short lot.

For many years I have had transmitters and receivers with 160 Meter coverage. Due to the limited size of my lot I was unable to erect a suitable antenna to allow full use of the equipment. My lot measured 150 feet by 50 feet, and, according to the formula, $\frac{468}{\text{f MHz}}$, I needed a wire 260 feet long.

Desperately wanting to operate on 160 Meter band, I gave the problem considerable thought. Before running out of ideas, I remembered the old 'flat top' antenna used in the days of 'wireless' and decided to do some experimenting.

The experimental antenna, as constructed, consisted of three wires, each 66′8″ long, spaced about 16″ apart, and supported by two end spreaders. The three wires were connected in series to make a length of 200 feet. One free end was connected to a 60 foot lead-in which gave a total length of 260 feet. In making the series connections, one end of the center wire was connected, with a jumper, to the end of one outside wire, and the other end connected in similar fashion to the other outside wire. Essentially, the antenna is a wire 260 feet long with part of it folded back on itself two times. The details of construction are given in **Fig. 1.** If a longer or shorter lead-in is required, the length of each of the three wires should be altered accordingly.

As an alternate, the wire could be folded back on itself three times instead of two to obtain a still shorter antenna. This arrangement was not tried, however.

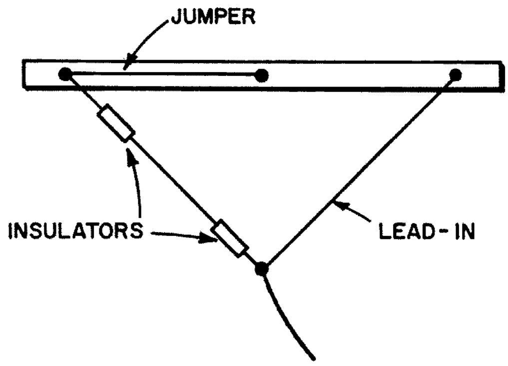
The wire used in the project was No. 23 cotton covered wire. The use of No. 12, 14, or 16 bare wire, solid or stranded, would undoubtedly have given much better results.

The construction of the antenna was quite simple and the results were very gratifying. Using about 65 watts on phone, solid contacts were made (from my former QTH in Philadelphia) with stations in Michigan, Ohio, and Vermont, as well as with many local stations.

If you have a similar real estate problem, try this antenna. If your results equal mine you will be well pleased.

I have a new problem. My present lot is less than 50 feet long. What do I do now?

. . . W3WPV



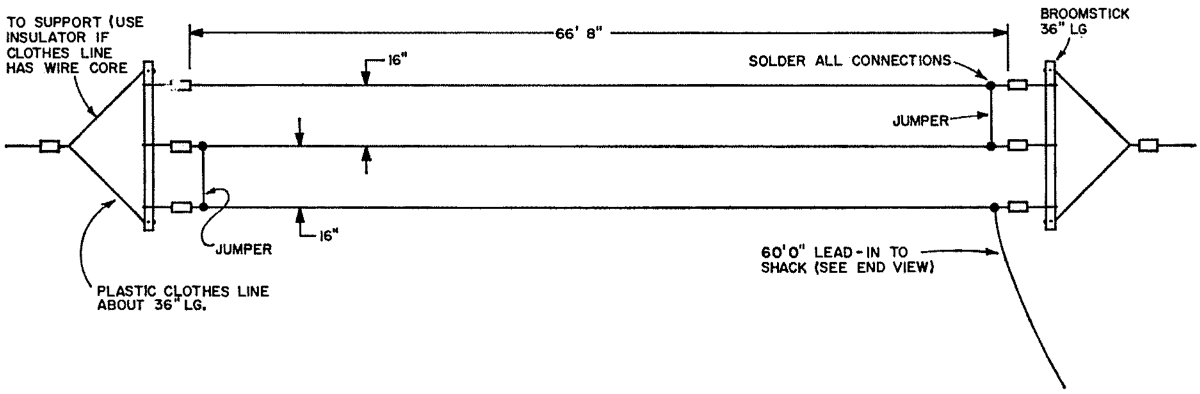


Fig. 1. Construction of the 160-meter flat top antenna used by W3WPV.

Walter H. Trefz K4UDP
3731—20th St. No.
St. Petersburg, Florida 33713

GO AHEAD! RUN AWAY TO SEA

Ever long to see the world while on someone's payroll? Ever wonder what it is like to be on the other end of a QSO with a maritime mobile station? Do you ever long for an "eye-ball QSO" with some of the DX hams you have worked or to know if the port cities of the Far East are really as intriguing as you have heard? Then what you need is to ship out and find out for yourself.

At the present time, due to retirement of regular operators, generous vacation plans (60-120 days a year), and the activation of over a hundred moth-balled ships for the Viet Nam war, there has developed an acute shortage of merchant marine radio officers. Conditions are now so critical that qualified men get ship assignments in a matter of hours (compared to weeks or months a few years ago) and frequently a ship is unable to sail due to a lack of a radio officer—they can sail without the 'ol man but not without "sparks". This has resulted in calling pensioned operators back for a few trips and delaying vacations for presently assigned operators but it still is not enough. Now is the time for prospective operators to enter the field, either on a permanent basis or whenever they can scrape together a couple months for a "relief" trip—usually one trip while the regular operator is on vacation, etc. Relief sailing is especially attractive to those with shore professions (such as teachers and students) as the peak relief-sailing months are during the Summers. In return for this type of sport, the pay and fringe benefits are excellent since you will be classed as a ship's officer. However, if you are an "operator" only and not able to repair and improvise, perhaps you'd better think twice before packing your seabag because most of the equipment on U. S. ships is over 20 years old and you can imagine what 20 years exposure to salt air can do to it. But, assuming you're still game, let's push on with the task of shipping out.

The first, and most important (and difficult), requirement is to obtain a second class (or first class if you're good enough) radiotelegraph license from the Federal Communications Commission. After obtaining this, you must get a "Z-card", (USCG radio officers license), and a vaccination or "shot" record (only if you're going on a foreign voyage and showing a small pox vaccination within the past three years—this can be obtained after you're assigned to a ship so don't worry about it now). Also, if you plan to make a foreign voyage—and who wouldn't since you have to go foreign in order to see the world, etc. etc.—not a requirement but a good idea is a standard, tourist-type passport as it will open many normally closed doors in some foreign lands.

To get the second class radiotelegraph license you need three things. First, you must pass a code test of 16 W.P.M. code groups (5-letters per group) and 20 W.P.M. plain language. Secondly, you must pass a comprehensive written examination, and thirdly, you've got to cough up $4.00 for the tests.

The written portion of the test consists of four parts. Element one is 20 multiple-choice questions on basic radio laws, international treaties, and regulations to which the U.S. is a party. Element two consists of 20 multiple-choice questions on basic operating practice and procedures for radiotelephone (most ships have voice ship-to-shore equipment). The third part is FCC element five which consists of 50 multiple-choice questions on radiotelegraph operating practice. The final part is element six which consists of 100 multiple-choice questions on advanced radiotelegraph pertaining to technical topics, message format and routing, and marine radio navigation. For those of you who enjoy examinations, it is to your decided advantage to also take the test for the "radar endorsement" which is composed of 50 questions pertaining to the theory, operation, and maintenance of shipboard radar equipment.

Now, for those of us who feel the above is a little too much to tackle in one bite,

a sneaky (and easier) way to do it is to first get a third-class radiotelegraph license which involves only the code test and elements one, two, and five. When this is obtained, cramming is concentrated on the more difficult element six since credit is given for the elements already passed in obtaining the third-class license. After obtaining the second-class license, preparation is then made for the radar endorsement.

Being careful not to smear the still-wet ink, take your shiny, new second class telegraph license in your hot little hands and rush down to the nearest Coast Guard Office of Marine Inspection and get things started on the next two requirements.

The next requirement is to obtain a "U.S. Merchant Mariner's Document" popularily known as a "Z-Card" because of the letter "Z" prefixing the seaman's identification number. This is a plastic, laminated ID card, issued by the Coast Guard, and shows the positions in which you are qualified to serve. In our case, you want it to show qualifications for at least "radio officer" (It is suggested you also apply for endorsements as "ordinary seaman", "wiper", and "food handler" since they cost nothing and you may need to sail in one of these capacities someday). In order to obtain a Z-card, you must have proof of citizenship (not necessarily U.S.), a social security card, and a "letter of commitment". This letter or job-promise requirement may, at first, appear to be an insurmountable obstruction because "you can't get a job without the Z-card and you can't get a Z-card without a job" but this is where the letter of commitment comes in. In our case, probably the easiest way around this is to write to the nearest radio officers union (in most major ports), tell them your aims and that you have a second class radiotelegraph license, and in most cases they can fix you up with the required letter. In the case of those who are Navy or Coast Guard veterans with sea service, a letter requesting a "transcript of sea service" sent to General Services Administration, Navy Branch, Military Personnel Records Center, 9700 Page Blvd., St. Louis, Missouri 63132 will do the trick.

The next requirement is the radio officers license, also issued by the Coast Guard. To qualify for this requires a minimum age of 19, a first or second class radiotelegraph license, a letter of commitment (same as

above), passing a physical examination, passing an examination on the "Ships Medicine Chest and First Aid at Sea", and the patience of Job because you will spend many hours completing forms, assembling records, letters of character reference, photographs, fingerprint cards, security questionaires, and then waiting for 2-4 months for it to be issued.

Now, several months later, you've got all the necessary documents. You hear foghorns blowing on the damp, on-shore wind, and you decide its time to start thinking about getting a ship and getting underway. On U.S. ships, in order to sail as the only operator on board, you will need an endorsement on your FCC license stating that you have served at least six-months as an operator on U.S. ships. Since freighters and tankers carry only one operator, job possibilities are severely limited without this endorsement. Those of you who have served as radiomen on board ships in the Navy or Coast Guard are already qualified for this endorsement. While not suggesting a hitch in the Navy to obtain this endorsement, some other ways to get it is to sail on a passenger ship as an assistant radio officer (these jobs are assigned through the unions) or to enter the Radio Officers Union apprenticeship program. Other ways are to work on various U.S. government ships as a radio operator, such as with the Military Sea Transportation Service, the U.S. Coast and Geodetic Survey, or on a research vessel belonging to the several oceanographic institutes. These jobs are filled through application to the individual agency concerned while almost all jobs on freighters and tankers are assigned through the two radio officers unions (American Radio Association and the Radio Officers Union). Those with the six-months endorsement can also apply to tankers companies such as Texaco, Humble, and Sun Oil, etc. for direct employment as a radio officer.

Now that you're all set to go, pack your seabag early and get your affairs on shore squared away because when called to a ship, you're usually phoned one day for a ship which is sailing the next day. Newcomers usually do not have much choice of the areas to which they will sail, but when you're new, the whole world is yet to be seen. Bon Voyage.

. . . K4UDP

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Radio Officers Union, Room 1315, 225 West 34th St., New York, N. Y.

Military Sea Transportation Service, 58th St. & 1st. Ave., Brooklyn, N. Y.

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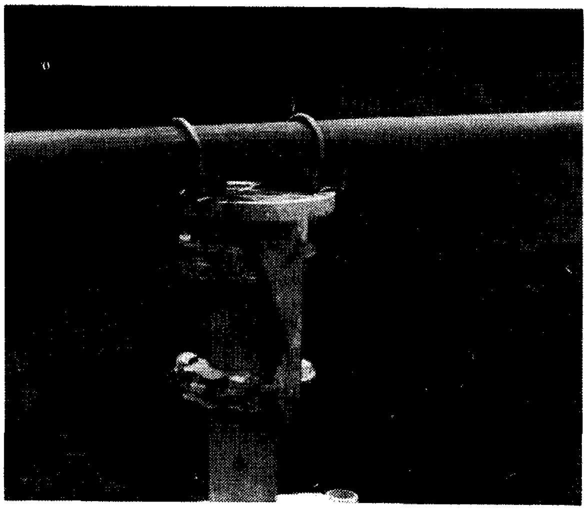


A Sturdy Boom Clamp

Don't throw away the bottom section of your C.D. rotator when you mount it in a tower. Shown in the photograph is the lower section of an AR 22 rotator used to connect the boom to the mast of a 20 meter 2 element quad installed at W6BKX.

Drill four holes in the flat section to fit the boom clamps, tighten it up and you have yourself a very stable connector. Boom length is 10 feet long here.

Old TV telescoping masts are useful for beam parts. The mast at W6BKX is the outside 2 inch section and the boom is the next smaller size. Just right for the clamps which were part of a Gotham quad kit.

The smallest inside diameter pipe in the TV masts should be discarded. They are not to be trusted for even the smallest of 20 meter beams. Mine twisted off in very moderate weather.

Paul A. White W6BKX

Ralph Steinberg, K6GKX,
110 Argonne Ave.,
Long Beach, Calif. 90803

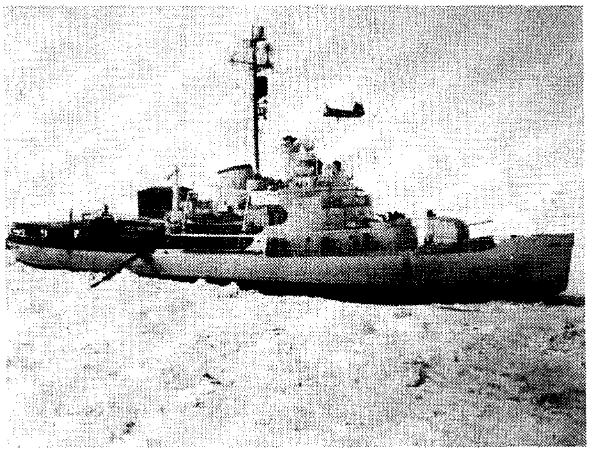
Operations Deep Freeze...1957-1967

The saga of ten years amateur radio in the Antarctic.

"Vast expanses of ice and drifting snow"! "Temperatures from 50 to 100 degrees below zero"! "Winter darkness and isolation"! These were some of the conditions at Little America V in Antarctica during Operations Deep Freeze III, from 1957 to 1958, the International Geophysical Year.

The history of Operations Deep Freeze III and the International Geophysical Year has been published in many magazines and books but little has been told about the momentous part amateur radio accomplished during this operation and still continues to do today. This immeasurable service to the lonesome and isolated men in the Antarctic should go into the records of achievements along with other public services the radio amateur has contributed.

To relate the story about Operations Deep Freeze III at Little America V, where our story begins, some description of how all the radio amateur activity started. Little America V, the fifth station to bear that name, was begun in early 1955, by Operation Deep Freeze I, with construction continuing through Deep Freeze III. In early 1957, operations were under way for the International Geophysical Year, with 352 men setting up housekeeping for the vital job to come. The ice breakers USS Glacier and Atka had the job of clearing through the ice pack so the ships could unload their cargo of supplies and equipment before the heavy snows fell. It was slow and tedious work chipping away at the ten foot thick ice barrier. With time becoming increasingly important, helicopters began shuttling cargo ashore and it was work around the clock for the men as temperatures of minus 50 fanned by 40 knot winds were constant. By the time unloading operations were completed the temperature had dropped to minus 70 degrees. With these conditions prevailing outside, work began on the inside of



Ice breaker USCG GLACIER clearing a channel in the Ross Sea so that the Navy supply ships can unload cargo at McMurdo Station.

the buildings sorting equipment and supplies. While some of the men worked on this task, others got the 19 house city called Little America completed with an interlocking tunnel, made of chicken wire and burlap, connecting every building. This work was finished none too soon as the buildings were snowed under so that the radar, radio and ground control antennas were all that showed above the snow.

With the buildings completed and the Naval communications center in operation, it was time to install the radio equipment for KC4USA. Under the guidance of Lt. Comdr. T. N. Thompson, officer-in-charge of Little America, the amateur radio equipment was installed and on the air in a very short time. Contacts to stateside were good and before long KC4USA became a choice DX station for the radio amateurs. There was always a pile-up of stations waiting for a contact and, under favorable conditions, KC4USA could be heard in most any part of the United States. DX contacts were fine but these isolated and lonesome men were anxious to talk to their loved ones at home. Knowing the great value of morale, Lt.

Comdr. Thompson made sure that phone patching was the order of the day, and under favorable conditions many happy voices could be heard on the 20 meter band.

There was drama and humor in those phone patches. As you know a phone patch is nothing private especially when you are sitting at the rig with a shack full of fellows at one end talking across thousands of miles to the other end, from Little America. For humor, there was one incident on a phone patch, where a fellow at Little America who had a German wife who every now and then would hit him with a bit of German in her conversation. The fellow was limited on his German and he would ask for a repeat here and there and sometimes would ask for an English version of it. Sometimes she would not give it to him in English and he would still be trying to figure it out for days later. On the dramatic side, there was a phone patch which helped save the life of a mother of one of the men at Little America. The mother was to have major surgery and her wish was to talk to her son before the operation. The patch was made and the doctors said after the operation that the mother, by talking to

After making connections with a ham in the states, Glenn K. Doebler, Jr. and John R. Haugh attempt to locate McMurdo personnel who desire a phone patch into the States. *Official U.S. Navy Photograph.*

Ice cave. Great place for a ham shack

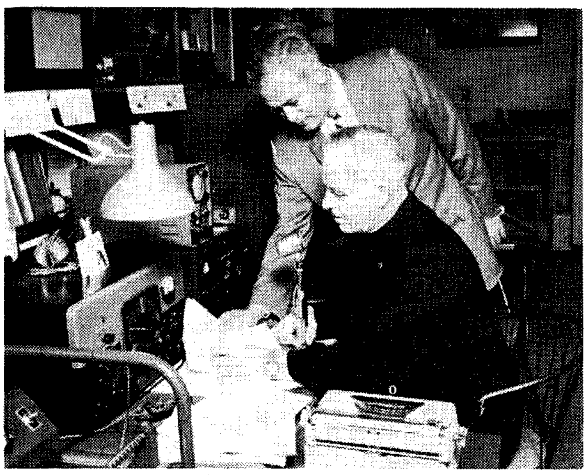
her son, came through with flying colors. There were many more humorous and dramatic phone patches but it would take a separate book to tell them all. A few common questions from the folks at home were, "Is it cold down there?" "When will you be home?" "Did you get the goodies I sent you?"

It was not easy to keep phone patches going through in bad weather. Antennas would blow down from the constant gale winds of the Antarctic. An idea and ambition came to the men at Little America to make a cubical quad antenna which was to improve their operation, both transmitting and receiving. Bamboo for the cross members was plentiful, so with a little welding, a few bolts, etc, not to mention some pure Navy talk, it was completed. It was intended to do wonders on 10-15 and 20 meters. This was mounted on the end of a 5 inch pipe which extended about 20 feet above the snow on the radio shack roof. On the lower end, about 4 feet from the floor, were a couple of steel rods mounted horizontal on the pipe, making the set-up look like a rusty periscope. The idea was to be able to rotate this whole lashup simply by a bit of pressure on the steel rods. It was a good antenna, but within a week, the end of the 5 inch pipe above the roof had become solidly frozen to the Ross Ice Shelf. Needless to say, it was not rotated until the temperature got warmer and then it went round and round like a windmill, when the gale winds came up.

Several months after Little America V was in operation, KC4USV at Mc Murdo station started their amateur radio activities with KC4USW at Ellsworth, KC4USH at Hallet, KC4USK at Wilkes, KC4USB at Byrd and KC4USN at the South Pole following a

short time later. These outpost IGY bases were built to take scientific observations during the International Geophysical Year. With the increase of more scientists and Navy men to man these stations, the population in Antarctica had grown to 4200 men in support of Operations Deep Freeze III. This increase in population made the Antarctic look like the "Gay White Way" in New York City. Bright lights on the long winter snows glistened like jewels and the wastelands of the Antarctic became alive with men and machines. Phone patching and traffic increased with the growing population, and more state side stations volunteered to handle the phone patching and traffic. Traffic nets were organized especially to operate to and from the Antarctica stations.

There was one more amateur radio station in Antarctica during the winter of 1957-58 which was not at an IGY base. Father Daniel Linehan W1HWK, operated KC4USC at a reconnaisance base near the present site of the Mc Murdo station. Father Dan with a group of U. S. Naval Construction Battalion men (SeaBees) was engaged in special studies of camp sites for the Navy.



Father Daniel Linehan W1HWK at the mike with Paul Blum W2KCR in Paul's shack.

The camp being a temporary one, no heavy amateur radio equipment was used and Father Dan brought his personal amateur gear with him. With 40 watts on AM phone and 50 watts CW, he had a lot of fun running messages for the personnel at the camp. At one tine, KC4USV, at Mc Murdo was out of operation due to trouble with their equipment, so Father Dan at KC4USC had to handle most of the traffic for them and send it back and forth by helicopter. Some of these messages were happy ones and

Antarctica's great white way.

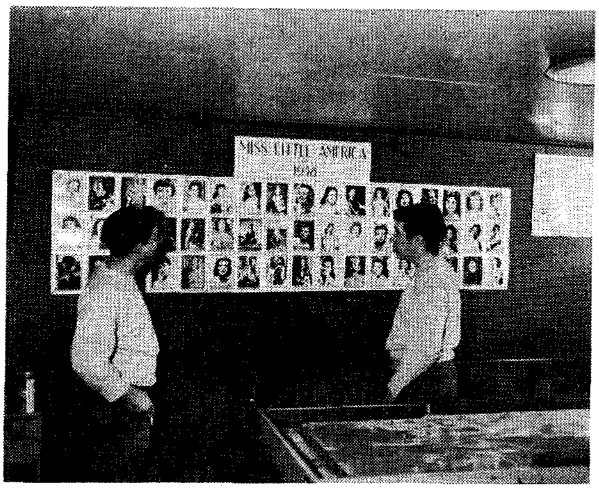
some were very tragic and it was difficult at times to determine which end of the message was the more lonesome. On one occasion, a Navy helicopter pilot called Father Dan from the 'copter on the ship-to-shore radio, when he was five hundred miles from the base to see if Father Dan at KC4USC could get some news about his wife who had been in an auto accident in Kansas City, Missouri. The Lieutenant had tried through other channels to get in contact with his wife but was unable to do so. KC4-USC went into action and contacted an amateur in New Jersey who put the phone call through to the pilot's brother-in-law in Kansas City, who gave a full story of the condition of the wife and child who was also in the accident. At the time of the phone call, the wife was still on the danger list at the hospital but the baby was unharmed. With the 'copter still many miles away, the pilot got the report of his wife's condition from Father Dan. A week later, the pilot was aboard a ship about ten miles from the camp and again contacted KC4USC to ask, if he came ashore, would he be able to talk to his brother-in-law in Kansas City once again. With a prearranged schedule, a Syracuse station was contacted and the pilot came ashore with the ship's doctor and captain. The ship's doctor was able to talk to the doctor in Kansas City and, with a few moments conference, the news came that the wife was out of danger. The pilot was so overcome he was unable to speak to his brother-in-law or the doctor. Needless to say, amateur radio had helped another man's morale that day in the Antarctic.

Besides handling traffic and phone patches, there were other services that the radio amateurs offered to the isolated men in Antarctica. At Little America V, a

newspaper was published called the Penguin which had the national and international news as soon as it happened. From the station of W2KCR in North Syracuse, New York, Paul Blum with four members of the Radio Amateurs of Greater Syracuse (RAGS) transmitted the first newspaper page by facsimile to Little America V, on May 5th, 1957. The transmission consisted of a cartoon, two pictures, news stories and a greeting. This was so successful that a one page newspaper sheet was transmitted twice a week, which now included more photos of people in the news, sports and of course, cheesecake (the girls usually wearing fur coats). About May 30th another news project was started called, "Operations Baby Face". Pictures of the new born babies were sent with each edition of the newspaper. Many happy fathers had their morale lifted by the picture of his new born child. One father received a picture of his son 18 hours after being born. This facsimile operation became so popular with the men at Little America, they gave it the title of "W2KCR Family Album".

Operation "Baby Face" with photo of new born baby.

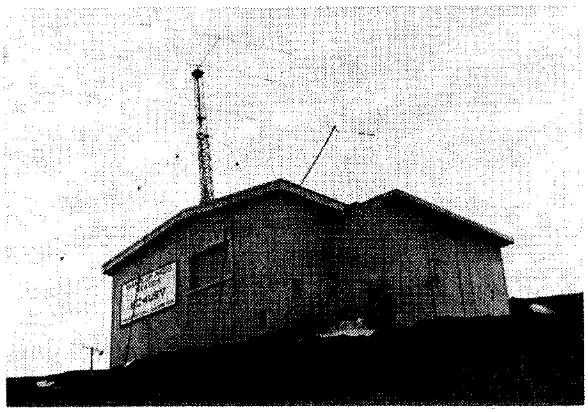
A bit of humor was also included in these facsimile operations. In the fall of 1958, the Miss America Beauty Contest was being held in Atlantic City so Paul, W2KCR, conceived an idea, as a morale builder, to stage a beauty contest at Little America and call it the Miss Little America Beauty Contest. The only difference between the two contests was that in the one at Little America the winner would be selected from the pictures instead of in the flesh. Pictures of the various state winners were transmitted to Little America and, as they were received, they were hung on a large bulletin board with



Miss Little America beauty contest

statistics of each of the Miss America contestants. To keep the selection of the winner completely impartial, the contestants were identified only by number. After heated voting in 67 below zero weather, Miss Massachusetts (36"-24"-36") was picked as Miss Little America of 1958. It was a close race with a hazeleyed blond from Tennessee but Miss Massachusetts won in the runoff. The winner was awarded a silver penguin which was paid for by the "residents" of Little America. All the news services carried the photograph of the Miss Little America winner and it hit the front pages of many newspapers throughout the United States.

In 1959, Little America V was closed, but Mc Murdo, Byrd and the South Pole stations were designated as permanent scientific observation stations. Mc Murdo Station became the hub of all communication activities both Navy and amateur radio. With Mc Murdo Station as the communications center, amateur radio activities also became a center of communications at KC4USV. In the summer months, the arrival of scientists from all parts of the world made Mc Murdo station look like some large city hotel with a "full house". Each night there was "standing room only" in the ham shack, waiting for phone patches to stateside. KC4-USV operated around the clock, with two or more operators on a shift ,to take care of this peak load of traffic and phone patches. As the summer months came to an end, the scientists returned to their homes and the "wintering-over" Navy personnel settled down for a long hard winter ahead. Antennas and equipment had to be checked before 100 knot gales with snow whip into the Antarctic. Even with the best of care,



KC4USV . . These call letters are beamed from the Navy ham station at McMurdo over 6,000 times a year. The steel cables over the ham shack are needed to hold it down during frequent Antarctic gales. *Official U.S. Navy Photograph.*

very often the antennas were damaged by severe storms.

From 1960 to 1962, Mc Murdo, Byrd and the South Pole stations took on a new look with a modernization program of antennas and equipment. At Mc Murdo station, a nuclear atom electric power plant replaced the fuel burning generators which had been in use since the IGY year. A new tower and a new Mosley TA 33 beam was installed and in the ham shack the complete 32 S Line (Collins) took the place of older equipment. With this work finished at Mc Murdo station, new antennas and equipment were installed at the South Pole, Byrd and Hallet stations. Highly directional conical monipole and uhf antennas were part of the antenna replacements at Byrd station. Upon completion of this modernization program, the capability of these stations improved considerably.

Through the years from 1962, Navy personnel were relieved of duties and others came to take their places. Amateur radio activities were much the same until this present year when Operations Deep Freeze 1968 got under way. With the summer season here again, operations at the Antartica stations are again at high peak. At KC4USV, amateur radio activity is increasing and some facts just received from there might give you a picture of their amateur radio operations. An average of 19.7 phone patches a day are put through to the United States and the world. The record number of phone patches for this summer season is 56 patches in eight hours. From October to March (the summer support season) approximately 3,000 patches are made. During the winter season, March through September, a total of 2800 patches were completed. An average of fifteen states are covered each week in the patching. A years total in phone patches averages about 6,000. Emergency phone patches are received and transmitted at any time as there are six regular ham operators at Mc Murdo. "Marathon" phone patch transmissions are held on major holidays; beginning on the holiday (Mc Murdo time) and ending at Midnight the next day. Besides all this phone patch activity, Mc Murdo station is also a member of the Navy MARS network with the call, NØICE. They operate with the east coast from 0100 to 0300 Zulu time. The midwest from 0300 to 0430 Zulu and the west coast from 0430 to 530 Zulu. Several thousand MARSGRAMS are transmitted and received each month. The outpost stations, KC4USB at Byrd and KC4USN at the South Pole, although staffed with smaller crews, participate in these amateur radio activities as well.

There are many radio amateurs to be commended for their participation in handling all the traffic and phone patches from and to the isolated men in the Antarctica. Some have participated in this dedicated work for more than ten years. Space does not allow a complete list of everyone who has had any part of the communication link between the men in the Antarctica and their loved ones at home. We will however list several of the radio amateurs who have been mentioned in the letters we received from the men who are now in the Antarctic or from those who have done duty there in past years. Topping the list (ladies first!) is Betty Gillies, W6QPI, who for the past ten years has seldom missed a schedule with the Antarctic stations to pick up traffic and phone patches. Her record of phone patches and hamgrams, during these years, total

Betty Gillies W6QPI picking up traffic from one of the Antarctic stations.

several thousands. Betty is also a member of Navy MARS and her call is NØAYT. Kayla Bloom, W1EMV, formerly WØHJL and KH6CKO, just happens to be the new editor of 73. Besides being editor, Kayla has done a lot ot traffic handling with the men at the South Pole station, KC4USN. When she lived in Kailua, Oahu, many hours were spent in this work but now being editor of 73 keeps her busy into the wee hours of the morning. There is also Captain Haud Gillis, W4UEL, pilot for Pan American Airways, who has, for the past ten years, been one of the regular scheduled stations picking up phone patches and traffic from all the Antarctica stations when not flying. W2KCR/W1CED, Paul Blum, mentioned earlier in this story, still does a lot of phone patching for the men in the Antarctica. W7ARS, Walter Nettles has had RTTY skeds with Mc Murdo and Byrd stations for some several years. Also on RTTY skeds with Byrd and Mc Murdo stations are K1TWK, Kenneth Nokes and John Terry, KL7DRZ. Kenneth Nokes is QSL manager for Byrd and South Pole stations. His address is Island Park Road, Ipswich, Mass. Charles Morgan, K1GZL does considerable phone patching for the men at Byrd station, during the winter months. Again to all amateurs contributing to this dedicated work, the men in the Antarctic "Thank You"!

It is now the middle of the summer season in the Antarctic and this brings more radio amateur activity. Scientific parties in remote areas are accompanied by ham gear. Picket ships and research vessels, USCG ice breakers and supply ships all have ham stations aboard. The call letters of these and the other Antarctic stations may be useful for reference in traffic handling and we list them as follows:

KC4USV . . Mc Murdo
KC4USX . . Williams Field, Mc Murdo
KC4USB . . Byrd
KC4USN . . South Pole
KC4USJ . . Plateau
KC4USH . . Hallet
KC4USP . . Palmer
KC4USL . . Little Brockton
KC4USG . . USCG Glacier
KC4USD . . Burton Island (USCG)
KC4AAA . . Research Vessel Eltonin
KC4USS . . Picket Ship USS Mills
KC4USO . . Picket Ship Thos. J. Gary
KC4USC . . Army Helicopter Squadron
KC4USM . . Satelite near Byrd Station
KC4AAO . . Byrd Satellite, long wire

Some of these stations are closed during the "wintering-over" period and the USCG ice breakers return to their home ports in the states.

Before we bring this story to an end, we wish to relate a human interest story of a radio amateur who has spent a good part of his life in the Antartica. Julian P. Gudmunson, KØOEE/NØANU, now stationed at Mc Murdo station, has recently returned for his fifth tour of duty in the Antarctic and looking forward to his sixth, next year. Julian arrived the first time at Little America in 1956 and wintered-over till 1957. He was one of the operators at KC4USA that year. In 1960-61 and 1961-62, Julian was one of the operators at KC4USV Mc Murdo and operated KC4USX at Williams Field. During the wintering-over period 1962-63, he was one of the operators at KC4USN at South Pole Station and also operated at KC4USB that year. In January, 1967, the National Science Foundation honored Julian Gudmunson by naming a mountain in Antarctica, Mount Gudmundson.

Through the years anateur radio and the radio amateur have contributed willingly to science and public service and a recent letter from Rear Admiral Robert H. Weeks, ass't. Chief of Naval Operations (communications) expresses the importance of amateur radio to the morale of Navy personnel, "The contributions which amateur radio makes to the morale of Navy personnel throughout the world are numerous and varied. Unfortunately, many incidents involving amateur radio have been lost to history because of documentation. There is a definite story to tell regarding the importance of amateur radio to personnel connected with naval operations in remote areas such as those in Antartica."

This is the story, in a brief way, about Operations Deep Freeze and the radio amateurs who participated in it. To those men of the Antarctic who are part of this story, we hope it has been a little insight of the many hours of happiness which amateur radio has brought to them.

I wish to thank Betty Gillies, W6QPI, Paul Blum, W2KCR, Julian Gudmundson, KØOEE, Father Daniel Linehan, W1HWK, Commander T. N. Thompson and all the Navy personnel who helped make this story possible.

. . . K6GKX

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The Crystal Shopping List

The ham who enjoys building gear usually has a number of projects in mind at any one time which require crystals. Hamfest and surplus store prices are attractive, but it is wearisome going through box after box only to come home and realize that you passed up a crystal which would triple onto the wanted frequency while hunting for one which would double. Moreover, the buck fever of bargain hunting does not improve one's arithmetic on the spot. The answer, of course is a list, but the trick is to prepare a list in such a way that the alternative frequencies which might be used are easily compared while the total list is in serial order to facilitate a quick search. Here is how this can be done.

Say you want to build six pieces of gear, a low frequency marker oscillator, a 21 MHz converter with two ranges (for cw and phone) feeding a Q5er, a 28MHz converter, a 50-MHz converter, and a 14MHz and 28MHz SSB exciter. Sounds complicated? Well, it takes more than crystals, but hunting all these crystals ot the next hamfest is easy, if you set up your list as shown in **Fig. 1.**

The two low frequency crystals are so different that they hardly complicate life. The rest fall in serial order by columns with alternates appearing in rows across the page. Now if you find a 6866, for instance, you know immediately that you have finished with that row and can strike off 5150, 6866, 10,300 and 20,600, all of which were possible alternates for the CW range on the 21MHz converter. If you wonder how all trese are so readily interchangeable, I recommend that you investigate the Robert Dollar oscillator as one of the best for overtone and harmonic generation. Just don't get ahead of me at the crystal table at the next hamfest!

. . . WA4UZM

MARKER	100 500 (Channel 70 or 360)								
28 SSB		6433				9650		19300	
21 CONV	5150	6866				10300		20600	
14 SSB	5200								
21 CONV	5225	6966				10450		20900	
50 CONV				8300			16600	24900	49800
28 CONV			7050 or 7075		9400 or 9433	14100 or 14150		28200 or 28300	

Fig. 1. The crystal shopping list.

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Witching for Better Grounds

This article is written with the idea that antenna performance can be improved by proper location of radials and/or ground rods being driven into more favorable earth locations. Low resistance grounds also improve reception by effectively lowering the power line noises at the receiver input, which in turn improves the signal to noise ratio of the received signal.

The basis for this article is the fact that some people have the ability to locate underground objects, pipes and water streams by so called witching methods. I don't believe that anyone has come up with an explanation of this phenomenon of witching, but the fact remains that it *is* being done—and with surprising accuracy. After talking with persons who have this ability, I have come to the conclusion that the ability must be partially hereditary. But first and foremost, the person making use of this ability has to believe in it himself. It only follows that there will be many non-believers. You can't convince some of them even after they have seen the results. As an example, I recently had the occasion of watching a so called "witcher" demonstrate his ability to a couple of "non-believers". They were making fun of him while trying to locate some buried water pipes. He made the statement that he could find a lot smaller objects than pipes. One of them said, "How about me burying a nickel in the dirt and you find it"? As it happened the witcher had shortly before, been practicing on small coins, so he suggested that one of the non-believers bury 3 nickels close together along a track recently left by a tractor wheel. This particular track was plainly visible for a distance of about fifty feet. In short order, the witcher, using two rods made from coat hangers located the 3 coins. The non-believers again hid the coins and again in 2 or 3 minutes the witcher had located the coins. You can imagine the disgust which showed on the faces of the non-believers. They simply walked away, mumbling, "I still don't believe it's possible".

There seems to be various methods used by various people in locating buried objects. I was recently told of a man in Alaska who used an ordinary crow bar for locating buried water streams. He was in great demand to locate spots on which to drill for water wells. When using the crow bar he would balance the bar in his hand and

when he passed over the source of water, the bar would dip downward. From experience he could get some idea of the depth of the proposed well.

I have seen other persons use willow branches, rods made of brass, copper or iron. My Uncle showed me how to witch for water when I was about 16 years old. He was following a buried stream by crossing back and forth over it as it passed under our front yard. He told me the pull was very strong and that it was impossible for him to hold the willow horizontal when he passed over any large body of water. In order to convince me, he told me to hold the end of the willow on one end with a pair of pliers. To my amazement, the willow twisted off in the grip of the pliers. He also told me at this particular time that the water would be about 12 feet deep. From the direction that he was indicating the underground stream was following, I scoffed at the idea, since it appeared to me that any water only 12 feet deep would have to rise more than that to get onto this small plateau on which he was witching. Well to make a short story shorter, I took my Father's post hole auger and made some extensions for it. I augered down at the spot indicated by my Uncle. Lo and behold, I found water at eleven feet. That made a believer out of me, but quick.

While I don't claim to have excellent sensitivity for locating buried objects, I have never-the-less located many water pipes, buried electrical cables, junction boxes etc. I have shown other persons how to do it, and many of them, it turns out, have better sensitivity than I do. For instance I was never able to locate the 3 nickels in the dirt. I have noticed one thing, though, that early in the morning, when my power of concentration is highest, that I do have more sensitivity than late in the day, especially if I've had a trying day at work. Up to this point the reader is probably wondering why I don't get to the point and tell him how to do it!

Making the rods

Simple but effective divining rods can be made from a pair of metal coat hangars. It is only necessary to cut the hook off of the coat hangar and bend the metal in the shape of an "L". The short side of the "L" should be about 5 or 6 inches long and the long side of the "L" should be 12 to 15 inches long. Smooth out any bends in the metal.

Using the rods

Hold the rods, one in each hand as shown in the picture. During "actual operating conditions", the rods are gripped loosely. I repeat, loosely. The hands will be separated about 24 inches apart, and the long side of the rod will be extended directly out in front of you. It is quite important to hold the rods horizontal, or in the words of the scientist or mathematician—approximately 90° from the forces of gravity. Actually the tips of the rods should be down perhaps 1/8 inch from the horizontal. This will assure that they will stay pointed straight ahead unless influenced by external forces. Remember though, if they tilt down too far, the tips of the rods will have to overcome gravity to turn in your hand. This will decrease the sensitivity. With the rods pointed straight out ahead of you, and with your hands about 24 inches apart, start walking slowly forward. As you pass over a buried water pipe, or underground stream, or other object, the rods will turn inward, and will come together. Walk up several times to the point where the rods turned in, to get the feel of things. Then walk up to the same point from the opposite direction.

You will probably find that the two points are separated by several feet. The pipe or water stream will be directly below the midpoint of the two spots where the rods turned in. The deeper the pipe or water stream, the farther apart will be the two spots where the rods turned in. You can move laterally 6 or 8 feet and repeat the process. In this manner you can trace the pipe or water stream all the way across your property. If you move laterally and cannot get another indication, it may be that the pipe made a bend. You will have to change your direction of walking so as to cross the pipe at an angle.

Now that you have mastered the art of witching, suppose we get back to the original purpose of this article, which I remember was to try and find a more favorable location for your radials or to find a wet-earth ground.

I am assuming that you have located and marked with stakes all of the buried pipes that cross your property. If you have a sep-

tic tank or cesspool in your backyard it might be a good idea to locate this and mark it so as not to locate an antenna post directly over it. If you are fortunate enough to have a large yard with water pipes underground, you can locate that new vertical antenna directly over one of the pipes. This will allow you to place two of the radials 180° apart and directly over a water pipe. I would also suggest that you run parallel wires for the radials which are directly over the pipe. This will increase the capacitive effect between the radials and the buried pipe. Radials can be easily buried in a lawn by simply drawing an axe through the grass to a depth of about 4 inches. Lay the copper radial in the slit made by the axe and tramp down the sod on either side. In a week or so you won't be able to find where you had cut the slit in the grass.

It may be worth your time, if the water pipe is not too deep, to dig down and fasten a ground clamp on the pipe directly below that new vertical antenna location. This will increase the effectiveness of the grounding system.

Now then, suppose you know that there are no water pipes in the area, but that you have located an underground stream. You can drive ground rods down into the stream and this will give you a wet-ground. Most of these underground streams run the year around, but even if they don't, the dirt will remain moist near the sand or gravel in which the stream was flowing. In any case a moist ground is better than a ground rod driven into dry dirt, which is almost 100% ineffective. One way to check to see if your ground system is effective is to make use of the commercial power. I am assuming now that the power company has their neutral grounded in various spots throughout the city. Generally this is done at the distribution transformer. If the power company uses a grounded neutral system, then you can connect a 100 watt bulb between your new ground system and the power company's hot side of the line. The bulb should light to near full brilliance if it is a "good" ground. If it doesn't light, try a 10 watt bulb. If the 10 watt bulb doesn't light at all, your new ground system is not going to be very effective. Remember, however that unless the Power Company's neutral is grounded, this system of checking won't reveal anything. *A word of caution*—110V can be dangerous. Connect the bulb and ground wire

prior to connecting the hot wire. Make sure you are insulated from the hot wire.

Here is hoping that you will be lucky enough to locate a "wet ground" right outside of your ham shack window. If you were not successful in this venture, but you located an underground stream over in the corner of your property, you have not wasted your time. Drive a sand point down into the underground stream and use the water to irrigate your garden. You might even use the water to form a "wet counterpoise", that is, by sprinkling, keep the earth wet around your radials at all times. HAPPY WITCHING!

. . . W7CJB

Bee Line Audio Filter

That little audio filter advertised by Ham Buerger caught our eye and we decided this might be something well worth a try. We were right.

The AJ-I is a variable audio filter for use with receivers or transceivers. It plugs into the output of the receiver, processes the flow of audio, and presents it to a 4-ohm speaker output or earphones.

The AJ-1 is designed primarily for CW work, but it does an appreciable job of cutting down on the QRM when listening to AM or SSB. The selectivity of the filter can be adjusted to drop out that annoying voice from the next higher channel.

There is a slight insertion loss of about 5 dB for the filter. The real loss is where you want it, above 3000 Hertz, those frequencies which interfere, but don't help communications. At 2000 Hz the filter gives you from 15-dB attenuation at minimum to about 45 dB at maximum. At 1000 Hz the filter gives a minimum of about 5 dB and a maximum of about 25 dB attenuation. There is little effect below 300 Hertz.

So, as you can see, the AJ-1 is quite a handy device. Not a bad deal for $7.95 at all. And once you get used to using it you just never switch it out of the circuit . . . everything is so much less noisy this way. On CW you can almost completely eliminate a signal just a few hundred cycles higher up the band. The CW bands being as vacant as they are these days, perhaps this is not important to you? ■

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The Ham

I met him, I liked him, I loved him. A month later he told me he was a ham. "Never mind, Dear" I said comfortingly, "You must be good at something, everybody is".

"No, you don't understand", he answered, "come home with me and I'll introduce you to the rig".

I had visions of a boat or a tent in the garden. I was totally unprepared for the room full of wires, metal boxes, switches, meters and other strange things that met my gaze.

"Mind yourself on the soldering iron", he said. He was to be saying it for the next 30 years or so.

"What is it all?" I whispered.

"It's my rig". A world of pride was in his voice and I knew in that moment that I'd met something to be reckoned with.

My mind switched to the new, but very small, flat we had chosen, and I murmured some words about perhaps managing to get rid . . . .

"Get rid?", he bellowed. The only time in the 30 odd years that have followed, as it happened, that he ever bellowed. So, I knew from that moment that this "thing" had to be lived with, and that I'd better make friends with it.

I got to know it well. Its' whistles, its' shrieks, its' howls, and from time to time its' effect on the neighbors, when it interfered with television. Even a night when his voice was heard coming over radios, and for some reason, a record player.

Yes, of course, he would see to it at once, but the band was open at the moment and the DX was marvelous. The Sun Spots had just taken hold and we were on our way out of the trough. Wasn't it just his luck the neighbors should complain *now*.

One by one, our three children arrived. They survived the nights of metal bashing as if it were sweet music. QSL cards ranged the walls. Government surplus became a household word.

I got used to people knocking on the door asking if G3GAD was in the "shack". So long as the kettle was always boiling for the endless cups of tea, things went on smoothly.

The walls of our now much larger house became covered with certificates, curling at the edges. DXCC, WAZ, WPX, and many others that were meaningless to me. A very high pole was as necessary to the garden as the roses. Indeed, wherever we moved, it went up first.

Field days were special dates, ringed in red in kitchen and shack on the calendars. Until *the* Field Day. He got a blast from some faulty equipment and was suddenly stone deaf. After innumerable tests at the hospital, he was told that nothing could be done.

The house was quiet. The whistles, groans, and metal bashing stopped. It was a sad silence. I would have done anything in the world to be able to hear all those horrible, but familiar, noises again.

Six months passed. The heap of metal and wires that had driven me crazy over the years, lay unused and covered in dust.

He sat up in bed one morning and smiled. "I think I'll just call CQ and see if anyone's about", he said. His hearing had returned. My Ham was back in his beloved headphones again.

**Wife of G3GAD*

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Getting the Most out of Link Coupling

Most of the VHF transmitter designs in the handbooks, and other amateur publications, use coupling links to transfer energy either between stages, or from the output tank, to an antenna of some sort. These links might either be loops around the output tank or linear networks if the tank uses lines. There are good reasons for using a link, including better harmonic rejection because of the lack of capacitive coupling that will pass everything, and maximum power transfer between stages. The added features of better harmonic rejection can be appreciated when we think of the horrors of a good case of TVI (and what that entails in the way of personal diplomacy to quiet the neighbors). Since we all work for the biggest signal we can squeeze out of any one circuit, we don't care to leave part of it in the tank. With so common a circuit in use, it might be nice to know more about it, so you can snow the hams who aren't informed.

What is a link? Basically a link is an impedance transforming device which takes the high output impedance of your driving stage and either transforms it to the impedance of your following grid, or transforms it to an impedance which will match the relatively low impedance at which most antennas operate. Since the transformer has been analyzed rather thoroughly in the past, it might be well to take this information and transfer it to the high-frequency realm of VHF.

A transformer is a magnetically coupled circuit consisting of two conductors in close enough proximity to each other so the magnetic field of one cuts the other. A varying current in either conductor will induce a current in the other. For maximum coupling efficiency, power transformers are wound on a core. Because of frequency considerations at two meters and up, the link can be just a single piece or wire near the high current portion of the plate lines. They both work in the same manner.

The theory and construction of linear plate lines has been well covered in past issues of 73,[1,2] but the proper method of tuning and setting up the output link has been left to chance. For the purposes of this article, I'll assume the link in the transmitter which you have built is proportioned properly and just go through the ways to make it operate.

Let's draw an equivalent circuit of a link: In this diagram the generator represents the voltage induced in the link through the transformer action caused by the proximity of the output link to the plate lines. R1 represents the series ac resistance of the link, R2 is the load, and the capacitor and inductor represent the series reactances of the loop. According to Kirchoff's voltage law, the sum of the voltage drops across the passive elements in the loop must equal the generator voltage. To get maximum power into the load R2 we have to maximize the voltage across it, since $P = \frac{V_2}{R}$.

Depending upon how you have the link tuned, you might have either series inductive reactance below resonance, or series capacitive reactance above resonance with its accompanying voltage drop. A portion of the remainder of the voltage is dropped across R1, and the rest is across R2. It is an easy matter to get rid of the reactance by making the inductor-capacitor combination series resonant at the operating frequency. We can make the drop across R1 as small as possible by increasing the Q of the network. At higher frequencies rf tends to travel on the surface of a conductor, the familiar skin effect. We have to make the surface area larger, and the easiest way to do this is to go to some sort of strap line for the link inductance. Silver plating is also a help, but if you use copper and polish it so that it is shiny and smooth, then coat it with Krylon, or something similar, so that it won't corrode, you will never notice the difference.

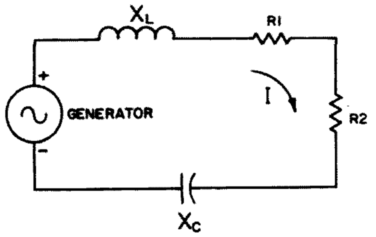

Fig. 1. Getting the most out of link coupling.

You will notice that I drew the antenna impedance as a resistor. It will act like a resistor if your SWR is 1:1, as it should be if you've been doing your homework and getting your antennas matched. However, most antennas aren't too broad, and will exhibit some reactance before you move too far from the frequency at which you tuned the antenna. No problem, since your link capacitor is variable and you can diddle with it until the link is series resonant again.

Some rigs don't use a series capacitor to tune the output link, but depend on stray circuit capacitance to resonate the affair. This is fine, for one frequency. Unless you have some way to retune the antenna, or use an external antenna tuner, you won't be able to move far from one frequency without loss of power. Witness the trials and tribulations of WB2HAL.[3] If you want to spend a little time, you can put in a capacitor, but you probably will have to pull a turn or two off the coil to bring the tuning range of the circuit back into line again. Let's explore the subject a little more.

The maximum power transfer theorem states that, for maximum power transfer to occur, the impedance of the load has to equal the impedance of the generator output; in our case the driving stage. However, if the load is reactive, then the generator has to have a component of reactance equal in magnitude but opposite in phase; i.e., if your load is inductive then the generator has to look capacitive and vice versa. You can still get power into your antenna, but to peak the power output you have to detune your plate circuit a little from resonance to again cancel the combined reactance. This gives your output tube a less than ideal load, and the extra current required for off-resonance operation does a nice job of heating your output stage.

Now, let's see how you tune your transbitter up the right way. If your link is fixed, it's a little harder than if it is moveable (the old guys with their seven-foot high, fifty watters had a good thing going for them). Put your SWR bridge in the forward position, or if you really can't borrow one, whip up some sort of field-strength meter and put it where you can see it while you are tuning up. Energize your rig and resonate the plate; now, peak the output while keeping the plate dipped with your plate meter. If you find that this loads the rig too heavily, *kill the power* and reach inside and pull the link away a little bit from the lines and then go through the routine again. If you do this carefully, you will find that your output peaks at the minimum plate current position. Try detuning the plate circuit a little to see if the power comes up. If it does, it means you still have a little reactance from the link side reflected back to the plate lines. Retune the link a little and try again. Assuming that the lines present a proper load to your output tubes, you will never have to say that "maximum power output occurs just a little off resonance." When you change frequency, just repeak your link and reresonate the plate to keep efficiency up.

A little hint for users of 4X150 series tubes; if your screen current is negative after this peaking process, your link is too big; go to a smaller link and increase your capacity a little.

. . . K1GBF

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1. WA4EPY, "Tuned Line Tank Circuits", *73*, September 1964.
2. W6GGV, "The Design of VHF Tank Circuits", *73*, July 1965.
3. WB2HAL, "The Second Requirement", *73*, November 1966.

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More on More Contacts from Within

In the urban society of 1967, more and more amateur operators are finding themselves cornered in the big city. Massive apartment complexes soar on all sides. The only grass in sight is the ground-up kind sprinkled onto pies in pizza parlors.

Since 73 published my do-it-yourself Joystick article in May, 1966, I have received over 100 letters and cards from hams across the States. They were all hungry for more on the apartment dweller's antenna system.

The correspondents asked questions, the answers to which are of value to any ham forced to use a miniaturized radiating system.

There are at least 50,000 hams boxed in, in urban areas, today. These fellows use some highly unorthodox structures to transmit from apartment buildings and other housing projects.

Super-thin wire is dangled from a twentieth-floor window after dark. TV, 300-ohm, lead-in wire is strung from corner to corner, across a spare bedroom. Insulated wire is run around a floor, under the rug.

In my system, as described in 73, poles with spring-loaded end pieces, such as those used in modern "tree" or "pole" lamps were used.

Loaded dipoles, base-loaded verticals, and center-loaded verticals using home-brew coils were shown.

Many readers' questions referred to coil dimensions for particular antennas.

Virtually every apartment-ham shack is different. Every antenna, even when constructed from similar home-brew materials, is different. An indoor radiator, such as the Joystick, is very sensitive to variations.

The location of the antenna in the rooms of an apartment and the construction materials used in building the apartment are major factors when the operator sets out to resonate his antenna at a desired frequency.

But, for a start, try winding coils of a heavy, rubber covered, solid, copper wire—such as electricians use to wire homes. Get a size that will hold shape well, yet be flexible enough to bend easily during winding.

Use the center cardboard from a bathroom tissue roll as a form for the coil. Take the cardboard out after construction and tuning of the coil—if the wire will hold its shape.

There is no way to get the coil circuit to resonate at the desired frequency without using a grid-dip meter, or similar instrument. Build the antenna with a guess-work coil in the circuit. Then use the grid-dipper while pruning the coil to desired frequency. Be sure to guess a coil size larger than the finished product so you can trim it down to size. Squeezing the loops of the coil, or pulling them apart, aids in the search for the frequency, too.

As with the most efficient outdoor antenna, an antenna-tuning matchbox is desireable. And, a matchbox is nearly useless without an SWR bridge so the operator can see just how efficiently the antenna is working.

Well-built outdoor antennas, fed from a matchbox following the transmitter, can be used with surprising efficiency at an end of the ham band far from the frequency at which the radiator was originally built.

Indoor antennas are not as flexible and their efficiency is less, but the matchbox will give the indoor antenna operator the flexibility to move some distance up or down the band from the antenna's cut frequency.

On occasion I have used an outdoor, half-wave dipole which was cut for 7100 kHz, at frequencies above 7200 kHz in the 40 meter phone band. I have been able to tune the SWR down to less than 1.5:1, even though the antenna cut frequency was 100 to 200 kHz away.

With the super-compact indoor antennas, the frequency is critical. It is sometimes difficult to get a low SWR on the antenna's cut frequency, let alone one far up or down the band.

It is not always possible to get that 1:1

ratio on the cut frequency. It has always been easy to get an SWR in the range of 2:1 or less. That range is not harmful to most transmitters.

The lower the frequency, the longer the wavelength, and the more the indoor radiator is compressed. Therefore the antennas are more efficient at higher frequencies.

With sunspot activity nearing optimum for this cycle, a 10-meter vertical indoors would give good results. Diligent construction and fine tuning of the system would be necessary as always. But it would be reasonable to assume QSO's with many foreign countries within range of a city-dweller's apartment.

. . . K3RXK

Somehow I don't think this marriage is going to work.

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S-9-Manship

The Art Of Achieving 40 dB Gain While Putting Your Contact 40 dB Down

". . . and turning it over to CEØXYZ on *Easter Island*."

Easter Island? Of course the CEØ was on Easter Island. And he knew that he was. Why then did that W7 mention his location?

For a long time, the significance of this apparent redundancy escaped me. Then one day it hit me—like hot solder dropped on bare toes. The W7 had mentioned the DX station's location for *my* benefit. He wanted me to be sure that I knew exactly how important was his feat. He intuitively knew that everyone listening would think well of him, admire his rig, and envy his operating technique if they fully appreciated the importance of what he was doing. He had wanted to impress me and he had succeeded.

This chance discovery was the turning point in my ham life. And in time I developed a whole new philosophy of amateur radio which in many ways negated the accepted and honorable standards of ham radio and raised—or threw down—the gauntlet. I'll never forget the day I opened my ARRL Handbook to "The Amateur's Code" and said, "Oh, yeah?"

You see, I had found that the real pleasures of ham radio are derived when one—regardless of rig, antenna, conditions, or operating technique—*comes out on top.*

Am I going too fast? Let me explain further. The joy of radio comes not so much from the working of DX, but with the satisfaction of knowing that others cannot work it. It is less the thrill of receiving an S-9 report than in *giving* a 4-6. . .especially to a brassy chap with a kilowatt and a beam. It is not the happiness felt when a kind ham comments on your good audio. It is the spine-tingling sensation you enjoy when you suggest that *his* audio needs a thorough going over.

I'm getting to you now, am I not? You smile, perhaps a little bitterly, at the audacity of these statements. But deep down you know I've touched a sensitive area. Just as the average man laughs at the fat man who slips on a banana peel, we delight in imagining that rich ham down the street turning on his rig and blowing every fuse in the house.

Now that we understand ourselves, let's see how we can use this knowledge to gain a certain status in hamdom that we probably do not deserve. Here, then, are the secrets and techniques of "S—9—manship".

The rig

The basic aim in this gambit is to appear to do a slightly better job than the other fellow. Run as much power as you can, but *never* acknowledge that you have anything but a 20-watt rig. *Always* ask for a signal report before giving one. If he reports your signal at 5 & 9, tell him he's doing a nice job despite the fact the meter shows only S-3. If he gives you anything less than S-8, don't bother to go back to him. Instead, respond to an imaginary break from a UAØ and carry on a one-sided conversation for several minutes.

The antenna

There may have been a time when the other fellow could be impressed if you suggested that you were using a giant multi-element beam or quad, but today it's not so. Why, you'd hardly receive an acknowledgement if you said you were using a beam *and* a quad simultaneously. No, the secret of coming out on top with regard to antennas is to announce that you are using an obviously inferior system-and getting remarkable results. I often casually reveal that I'm loading the aluminum siding on my house. And when stunned silence greets

me I offer to put the "antenna" on him a little better—by opening the garage door.

DX

Don't worry about DX. Don't even bother to work it. Just *call* it. Cleverly. For example, tune up on 10 meters when short skip or *no* skip can be heard. Call CQ, then, "QRZ the VU2." You might then do something like the following. "Oh, it's you, Sarvapali. Didn't expect to hear you coming in *again today*. You're booming in. Easily 20 over 9. Yes, we'll be there for the tennis matches in Bombay. Thanks so much for offering the guest house *again this year*." Who could fail to be impressed after hearing this? And remember, even on a "dead" band, h u n d r e d s, perhaps thousands, *are* listening. Just imagine them twisting their dials, cursing their antennas and tearing their hair as you—not they—apparently work a bit of exotic DX.

The ham club

Participate in club activities, but do the things that will help set you apart from the ordinary. Try strolling up when the gang is going over the schematic of a new rig and off-handedly (and just audibly) say, "I'm sure that .003 should be .004." Then, quickly walk away. Find a way to remark about the warmth of *Australian* wool. And the first time you get a puzzled look, say "Tim, down there in Perth, and I have been exchanging gifts for years. *I* gave *him* a 75S-3B for Christmas.

You might do as I do with the "screw driver gambit." I like to pull a small screw driver out of my pocket and when someone is operating the club station make a brief *if* adjustment in the receiver. Of course, you must be careful. Once I stuck my screw driver in a chassis, smiled mysteriously, mumbled something about the *if* being a little off, and remember (just before I lost consciousness) seeing my screw driver melt in my hand as it shorted the B plus to ground.

What has all of this gained me? And what can it do for you? It has made me the envy of my friends and it can do the same for you. How do I know? Little things tell me. When I attend club meetings now, the other members stare at me with awe and disbelief—obviously aware of their shortcomings and too shy to match knowledge or experience with me. On the air, it's much the same. After a transmission or two—after I've used my "S-9-manship"—they often plead QRM or a previous schedule and sign off quickly. And even in the ham magazines, my techniques have received considerable comment—usually in the letters-to-the-editor section. Most of the writers try to hide their envy and appreciation behind some accusation such as "kook" and "jerk." But I know what they *really* mean.

Looking for a way to gain a unique position in the ranks of amateur radio? Try "S-9-manship." I guarantee that as soon as you do, former friends will rush to get out of your way and every ham—even the one you're working—will clear the channel!

. . . W6DFT

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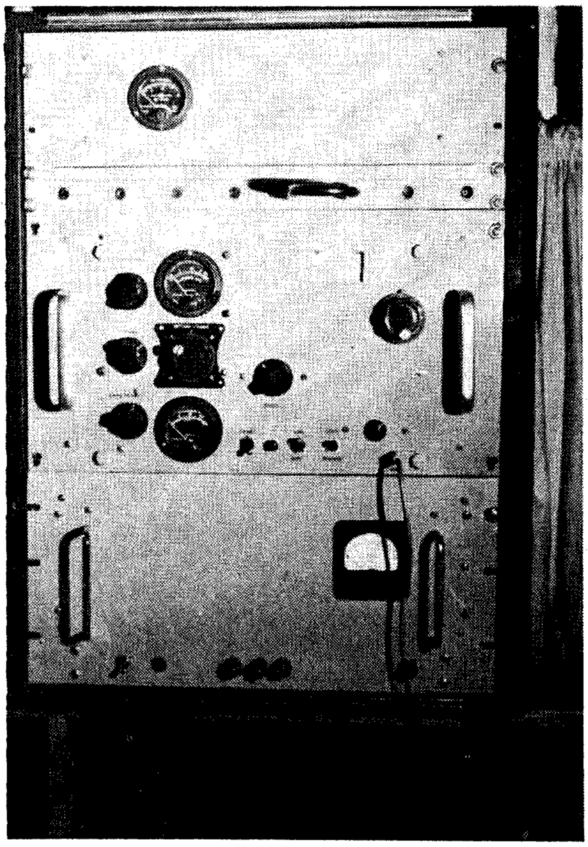
The RF Patch

A New Solution to an Old Problem

Mention the term"patch" to an old timer and he will probably think of the days when the only meter in the shack was mounted in a black bakelite panel and patched to the meter circuits by means of a phone plug on a long cable!

Modern day telemetry system patching components are a far cry from the early ham radio approach. The telemetry systems designer has had a wide variety of high quality video patching components manufactured by such firms as Vitro, Trompeter and Whistler electronics. These components were of little interest to the radio amateur due to their power and frequency limitations. Of course, rf patches were built, but for the most part they were very cumbersome and expensive.



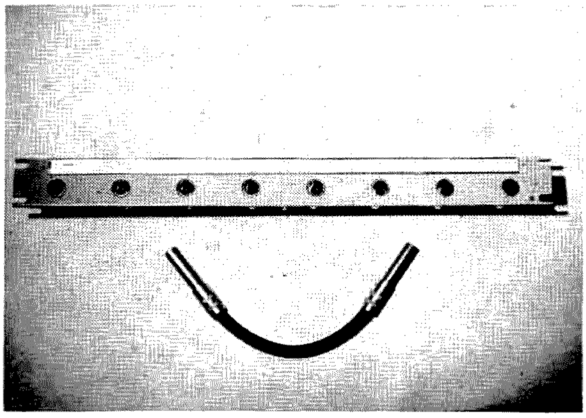
The eight cell panel installed in a rack.

Recently there has been a break through in the field of rf patching components that is of considerable interest to the radio Amateur. This is a series of components manufactured by Whistler Electronics for their "large patching systems." The original design was primarily for patching transmitting and receiving equipment operating in the newly activated 2.4 GHz telemetry band. The components are compatable with all amateur frequencies from the 160 meter band through 10 GHz.

The patching systems consist of a patch panel containing from 8 to 36 jacks. The jacks have a type N connector on one end (just the thing for that surplus co-ax) and accept a special plug at the other end. The jack will handle anything that RG-8 cable will. In fact, I tested them to 15 KV for insulation break down.

The WR-7 jacks are available mounted in a standard 19" relay rack panel. The antennas, receivers, and transmitters are terminated at the rear of the panel. Any cell can be patched to any other cell by means of a WC3-5-1 patch cord, or if the cells are adjacent by using a WBPN-5 looping plug. The plugs are not threaded but simply slide in and out. Their design is such that positive contact is assured. 50 ohm impedance is maintained throughout the system. Using a little ingenuity, the cell assignments can be made so that all normal patching is done using looping plugs, keeping patch cords to a minimum.

The rf patch is a much needed accessory in the sophisticated shack which contains a variety of receivers, transmitters and antennas. It sure beats crawling behind equipment to unscrew connectors when changing receivers or bands. I have found it very convenient in my shop as I am constantly changing antennas to test out various pieces of home brew equipment. For this purpose, a WP-3 plug on a test cable provides for rapid connection to any cell.



An eight cell rf patch capable of handling a KW. A typical patch cord is shown below the panel.

Cost of a home built system is fairly reasonably. The individual jacks cost about \$7.50 each. More detailed information on the components and systems can be obtained by writing Harvey Hunt, Whistler Electronics 18718 Bryant Street, Northridge, California.

. . . W6JTT

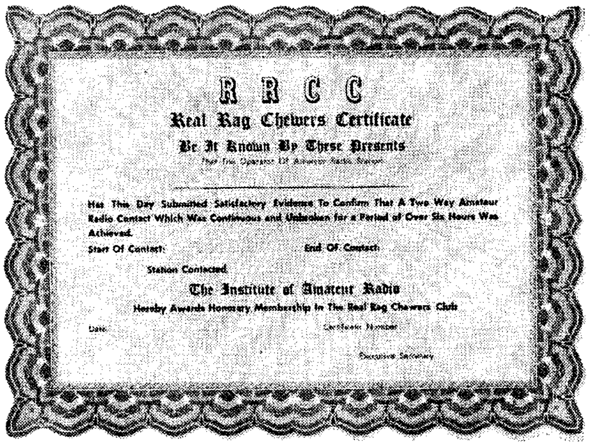
New books from Sams

Fundamentals of Digital Magnetic-Tape Units, by the Univac Division of Sperry Rand Corp., was written originally for use by it's own organization. It has proved so successful that it has been published for general use. This book presents a thorough background for understanding magnetic-tape units which are coming into wide use for information storage. It presents basic facts about magnetism and magnetic fields and shows their application in magnetic-tape recording. The book contains many illustrations and operators, programmers, troubleshooters, and maintenance technicians will find it helpful. Catalog No. 20580 List Price \$2.25.

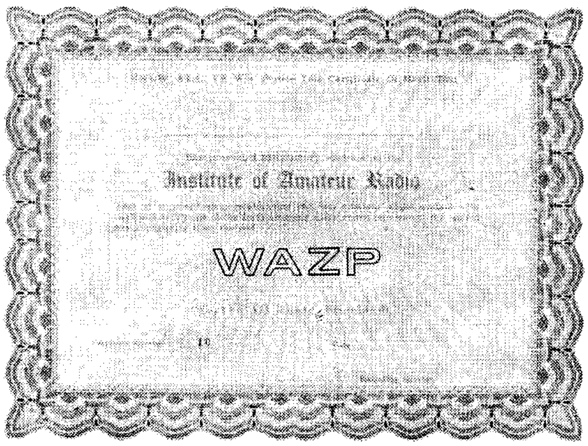
Know Your Sweep Generators, by Robert G. Middleton, is the latest in the Sams "Know Your" series. This book provides a handy reference and guide for the experienced technician, and is also a textbook for students in technical institutes and junior colleges. It provides a detailed background on the basic principles of sweep alignment, methods of FM test-signal generation, and the operation of beat-frequency generators and associated instruments. Catalog No. 20593 List Price \$3.25.
Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, Indiana 46206.

73 Certificates

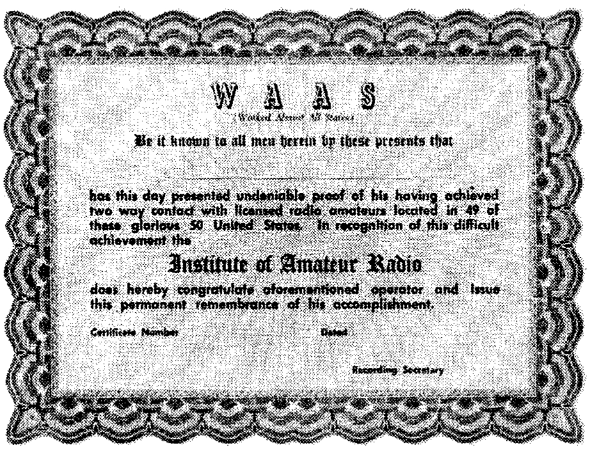
Since a recent article (*The Longest QSO,* 73 November 1967) mentioned a certificate issued by *73,* we have had numerous requests for information on the R.R.C.C. (Real Rag Chewers Certificate). Since it has been several years since we have publicized our certificate program, the rules for all 73 certificates (except WTW) follows:



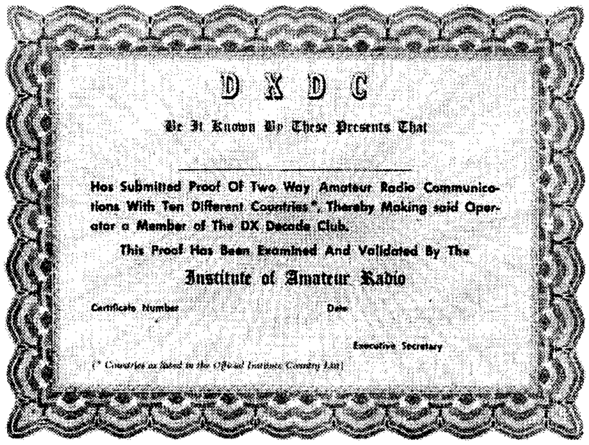
R.R.C.C. This certificate will be awarded upon satisfactory evidence of a QSO between two (only) amateurs which lasted more than 6 hours. The contact must have been continuous and unbroken.



W.A.Z.P. (Worked All Zones Promised): Any amateur who shows evidence to the awards committee that he is *intent* upon establishing two way amateur radio contact with each and every one of the forty amateur radio zones into which the world has been arbitrarily divided, is eligible for this award.

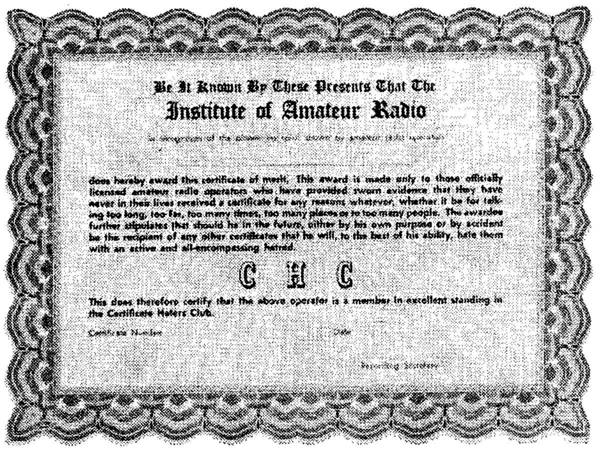


W.A.A.S. (Worked Almost All States): This certificate is awarded to any amateur who submits undeniable proof of two way communication with 49 of the 50 states.



D.X.D.C. (DX Decade Club): Any amateur who submits proof of two way amateur radio communications with ten different countries is eligible to become a full member of the DX Decade Club and will receive this handsome award.

C.H.C. (Certificate Haters Club): This award is made only to those officially licensed amateur radio operators who have provided sworn evidence that they have never in their lives received a certificate for any reasons whatsoever, whether it be for talking too long, too far, too many times, too many places or to too many people. The awardee must also stipulate that should he in the future, either by his own purpose or by



Be It Known By These Presents That The
Institute of Amateur Radio

does hereby award this certificate of merit. This award is made only to those officially licensed amateur radio operators who have provided sworn evidence that they have never in their lives received a certificate for any reasons whatever, whether it be for talking too long, too far, too many times, too many places or to too many people. The awardee further stipulates that should he in the future, either by his own purpose or by accident be the recipient of any other certificates that he will, to the best of his ability, hate them with an active and all-encompassing hatred.

C H C

This does therefore certify that the above operator is a member in excellent standing in the Certificate Haters Club.

Certificate Number

Date

Recording Secretary

accident be the recipient of any other certificate, that he will, to the best of his ability, hate them with an active and all-encompassing hatred.

A fee of $1.00 to cover handling and mailing shall accompany all requests for each certificate.

Note: These certificates are *not* recognized by the Certificate Hunters Club, and may jeopardize your standing in that organization.

Bill Hayward WØPEM
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TUBE Abuse in SSB Gear

Upon making a trip to one of the area radio stores and talking with one of the servicemen there, he showed me what was left of a pair of 6HF5's. The glass bulb was just like someone had put his thumb through it, while the glass was being made. Why this abuse of tubes, I thought? Maybe we all need an education on the use of all these new type tubes (at least new to the ham field).

In this day of 6JB6's, 6HF5's, 6GJ5's, 6DQ5's that are used in present day SSB transmitters and transceivers, you find that it takes a bit more care in antenna matching, tune up and key down condition. Most all of this tube abuse could be eliminated if hams would only take time to read and understand their instruction manuals. But, not seeing this happening in the foreseeable future, what then is the answer? I would suggest that persons using new type SSB transceivers, transmitters confine their tune up to not longer than 20 seconds at one time with a cooling off period of at least 5 minutes.

The good old days of the 807, 813, 6146, etc., when you could turn the plate switch on and walk away from the rig for a half a day at a time, and come back and still have a tube left, are gone. These new type tubes just won't take that kind of treatment. Most of these tubes are horizonal oscillator for color TV sets and as such have no rating for rf power. But, the peak power used in SSB transmission is only micro seconds, so these tubes work wonders when used this way.

Why then do manufacturers use them? Because, they will do the job on the SSB and CW modes (this is one reason that you don't find AM on the rigs today), cost less (6GJ5A cost $2.74 while a 6146 cost $5.20), are smaller to use and are more readily available on the open market for replacement purposes.

What can you do about using these new type tubes? Well, first, on most SSB transceivers you can peak up the receiver and the transmitter section will be fairly close to tuned up. Second, have a good match to your antenna. Third, when in the tune mode, tune up quickly and don't let it stay in this mode for more than 15 or 20 seconds, or good bye tubes. Fourth, you don't have to run your audio up to where it is pinning the meter (such as in the days of the big modulators).

Again *read* your instruction manual for correct tune up procedure. If you don't have a manual you can get one from the company which makes the gear you are using for around $2.00. So, lets all stop this tube abuse and see how many hours you can out of your tubes.

. . . WØPEM

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Transceiving With an Outboard Receiver

Although transceivers are very widely used today, many hams would be extremely pleased if they could combine some of the features of their station receiver with their transceiver; noise limiting, variable passband, Q-multiplier and added audio circuitry are just a few of the things that are desirable. The addition of these few devices would greatly improve reception. This article describes how the station communications receiver may be modified to transceive with a SSB transceiver.

In this application, the station receiver is actually used as an elaborate *if* strip. After determining the fixed *if* frequency of the transceiver (the center frequency of the crystal filter), the outboard receiver is tuned to that frequency and connected to the *if* of the transceiver. Some experimentation may be needed in choosing the proper tap point, but some of the following hints may be helpful.

The transceiver connection should be as early as possible in the chain of the transceiver's receiver section. Since each stage of amplification introduces a certain amount of noise, hooking in near the front-end will preserve the signal-to-noise ratio of the set. Also, you have to decide whether to tap before or after the crystal filter. In most cases the best tap point is in the *if* strip—after the crystal filter. This approach provides added filtering and image rejection before the signal is fed into the outboard receiver, and results in excellent gain and selectivity. As a rule of thumb, best results will usually be obtained by hooking on to the plate of the second *if* stage.

The cable which feeds the transceiver signal to the outboard receiver can be of any convenient length, and should be connected to the transceiver through a 10 pF capacitor of suitable voltage rating. Do not tap directly on the input or output of the crystal filter, as this will detune it and alter the passband on transmit; do not tap a stage common to both receive and transmit, because this may steal power from the exciter, and probably reduce drive on transmit. Also, do not tap too near the product detector, for this will introduce a strong BFO signal which may override the desired signals in the outboard receiver.

The author is presently using the above system with a Drake 2B receiver and an Eico 753 transceiver. The transceiver *if* frequency is 5.2 MHz; in order to put the Drake 2B on that frequency, a 9.0 MHz accessory crystal is used in bandswitch position "B". To lock the receiver onto the transceiver, the receiver is tuned around 5.2 MHz until the signals from the transceiver receiver are heard. At this frequency, the transceiver BFO signal is found and *zero beated;* this results in proper transceiving.

Naturally, provision must be made to mute the receiver on transmit. Most transceivers have spare contacts for controling a linear, and these can usually be connected directly to the receiver's mute terminals.

Suggested connections

Transceiver . . .	IF Frequency . . .	Tap plate of . . .
EICO-753	5.2002 MC	V5
HEATH SB-100	3.395 MC	V4
SWAN-350	5.1728 MC	V8
NATIONAL NCX-3	5.2000 MC	V11
DRAKE TR-4	9.0000 MC	V12
HALLICRAFTERS SR-150	1.6500 MC	V5

Table 1. Suggested tap points for various transceivers for use with outboard receiver operation.

One final word: to return the transceiver to normal, simply turn off the outboard receiver and turn up the transceiver audio!

. . . WA2APT

A Hams Shack Is His Castle

Or so it should be. But when your life is shared with a female, nothing is sacred. Now don't get me wrong. I think my XYL is tops and if she wants our living quarters neat and orderly that's all right with me. But she doesn't stop there. She's forever nagging me to clean up that "death-trap of a shack". It's a little old building across from the patio and looks all right on the outside so why should she care how the inside looks? If my goodies are strewn over the floor it's because I like them that way—when a part is needed I know just what pile to paw through. Another thing, with a mess like that—no one else dare enter for fear of breaking a leg.

But men stronger than I have conceded under constant condemnation so when our town conducted its annual "Clean Sweep" campaign (the motto being: "Paint it, Repair it or Throw it out"), I decided to do my part. Besides, those participating were entitled to free trash pick-up and what dedicated ham would resist anything free.

Disposing of acquired treasures was not easy to contemplate, let alone do, especially when some of it dates back to sub-teen years. But my mind was made up (for me) so, with stiff upper lip, closed mind and eye, I discarded.

Obsolete, moldy and rusty items went first. Next ageless tangled, piles of sticky-coated zip cord, then literally miles of useless coax, various lengths of frayed twin lead, and old chassis ended on the monstrous junk heap in the driveway.

My XYL is blessed with an unusual amount of false pride, so to hide the mess, she'd park the car sideways in front of it. Having it exposed to full view of the world was more than she could take.

Until—her sister came by one day and gasped this remark, "You aren't sending that stuff to the dump? Why? It's worth cash. Strip that wire—segregate that aluminum, brass and copper. The foundry pays good money for that kind of junk".

Well the XYL's ears perked up, dollar signs flashed in her eyes and her attitude took an about face.

In the following two weeks she learned more about what went into making ham radio tick than she had in all the years of tolerating my hobby. Donned in shorts and halter, she'd sit in an old lawn chair, in the middle of that mess, working at an improvised tool-strewn bench, sunbathing, stripping and destroying hour after hour. Transformers were dismantled in record time. The evening hours were spent in front of the TV unwinding the copper threads. The flipping noise of wire against paper was distressing but it made for a nice family sit in, so I said nothing.

The junky driveway didn't bother her anymore, in fact, the mess she made was ten times worse than mine with boxes and piles of stuff all over the place.

The biggest pile was the zip cord and coax which she stuffed into an old oil drum to burn. When lit, the entire neighborhood was engulfed in a great pall of black, billowing smoke. Flustered and embarrassed she explained to the firemen that she didn't realize it would smoke so much. Polite but obviously annoyed they departed with the comment, "Next time either warn us in advance or burn less at a time".

Undiscouraged, she was soon back on the job stripping twin lead by the yard. It got so she could tell, at a glance, what component had a coil hidden in its confines. She learned all about wire and could tell the difference between pure copper and other metals. She saw the painstaking intricate work that went into every piece of gear I had built, as she tore into project after project with screwdriver and pliers. The cutters flew as she salvaged every last inch of connecting wires.

I began to get uneasy, as her work neared an end, for fear she might rummage around the shack while I was out earning a living. She added to my apprehension when she

kiddingly remarked, "By the way, I found a real good piece of wire hanging from your antenna this morning".

She may have been kidding but I sighed with relief when she announced that tomorrow was the big day—she was taking her loot to the foundry. Just to be on the safe side I took a moonlight inventory and sure enough there in a box was my supply of p.c. boards.

She did pretty well, got $32.10 for the lot. Who else but a person dedicated to destruction would work for fifty cents an hour. True to her gender she spent twice that amount but her explanation was simple, "I bought only things I needed and look what I saved by salvaging all that junk". I understood, and no further comment was necessary.

She was happy—the shack was clean and orderly—but somehow things wern't the same. The soldering iron no longer beckoned. Could be I was afraid to start something for fear the needed parts would be among the missing. The place didn't even sound the same.

My melancholy was short lived. After pawing through my remaining goodies and dumping some of them back on the floor I added some parts discarded, under similar pressures, by a buddy, purchased more from the surplus store and in no time at all I had my castle looking and sounding just about normal again. It was private and disorderly and no one dared enter for fear of breaking a leg.

. . . W6LNG

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We want to make absolutely sure that no one is using our 73 mailing list. We do not rent this list out as do other magazines. If your address label from 73 is distinctive and you find that you are getting any mail addressed in the same distinctive way please let us know immediately and send us the envelope or wrapper that you received so we can take appropriate action. Your help in this will be very much appreciated.

International OX Crystal Oscillator Kits

If you're like most experimenters, at one time or another you've had some serious trouble with transistor crystal oscillators—instability, frequency jumping or spurious outputs. Don't fret any more—International Crystal has come out with a unit that will solve all your problems. The new OX Oscillator kit is a broad-tuned one-transistor circuit which provides oscillation over a range of frequencies by merely inserting the desired crystal.

Although the OX was designed specifically for the new EX (EXperimenters') line of International Crystals, it works quite well with all the crystals that I have tried. Since the crystal-controlled signal will be within 0.02% of the nominal frequency with an EX crystal installed, it is intended primarily for general purpose applications where precision is not required. For experimenters, it is ideal.

There are two OX kits available—the OX-L (low frequency) for 3000 to 19,999 kHz and the OX-H (high frequency) for 20 to 60 MHz. The price on each of these units is $2.35, and when I saw what came in the kit I was astounded. Getting out my latest catalog, I priced out the parts—it came to $3.40 and I hadn't even counted the printed-circuit board. With the cost of the board thrown in, the total value would be pretty close to $4.00. So, not only do you get an oscillator that works well, you get one that you couldn't build with all new parts for the same price!

The OX circuit is extremely compact, so it will fit into almost any application you have. Power consumption is low and it requires a power supply of six volts. Power output is on the order of 1 milliwatt so it is ideal for service as a local oscillator or crystal-controlled signal generator.

My first application for the unit was a small 50-MHz converter with the local oscillator at 36 MHz. It turned out to be one of the simpliest and fastest converters I have ever put together. No detectable birdies from surplus oscillator products—you put the crystal in and you're right where you want to be. The converter worked so well that I added a couple more transistor stages and a diode mixer and came up with a transmitting converter on the same chassis—three by five inches. No problems here either. With my 50 milliwatts out on six I was able to work three sections during the June VHF contest.

The next project, if you want to call it that, was a two-meter band edge marker. A single transistor tripled with a tuned output at 144 MHz was link coupled to the OX oscillator—in about ten minutes I had a crystal controlled marker. Plenty of output too. Next step—432. A 1N82A tripler into a 432 tank circuit provided a strong marker for that band. Not bad for one hour's work.

If you really want to go QRP, the OX oscillator kit is a natural. W70E has managed to chalk up some pretty good DX with the OX Oscillator Transmitter which he describes on page 111. Although he used CW in his experiments, you can modulate the oscillator without any difficulty at all.

If you do any experimenting at all, you're missing a good bet if you're passing up the OX oscillator and the EX crystal. The problems and money you will save are only your own. ■

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

The New Whip

A Report on the WTW

Not enough "extra" cards sent in yet to start our "Honor Roll". See The November issue of 73 for the new rules of submitting less than multiples of 100 for your Honor Roll listing. Send them in fellows so we can start our Honor Roll next month.

To date we have issued a total of 67 WTW Certificates. Broken down like this:

43 WTW-100 14MHz phone
9 WTW-200 14MHz phone
7 WTW-100 21MHz phone
3 WTW-100 28MHz phone
3 WTW-100 7MHz CW
2 WTW-100 21MHz CW

This is not too bad for a new DX Award. The interest is growing by leaps and bounds.

There is still Number *ONE* Certificate QRX for WTW-100 on 28 MHz CW

" " " " " WTW-100 on 7 MHz Phone
" " " " " WTW-100 on 3.5 MHz CW
" " " " " WTW-100 on 75 phone

and both CW and phone on 160 meters, even 6 meters if anyone ever qualifies! When we say PHONE we mean just that—it can be either SSB, AM, FM, PM etc.

I ask everyone to always place their full address with ZIP CODE on every form they send me, this means the address of the stations that qualify even when they submit their cards to a Certification Club. This will save me a lot of time in looking up addresses with the chance of having an address incorrect.

Have had a little trouble with fellows sending cards for the wrong band or wrong mode a few with both wrong on the cards. PLEASE POLICE your cards carefully fellows because YOU DON'T QUALIFY UNTIL I HAVE the right number of cards with the mode and band agreeing. With me its FIRST COME with the serial numbers on Certificates.

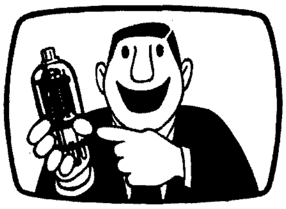
Don't send me cards, SEND THEM TO YOUR CERTIFICATION CLUB, if you don't know who that is an SASE will put one in your hands. We have almost every district covered now EXCEPT THE FIRST, SECOND AND ZERO DISTRICTS OF THE USA. STILL NEED AFRICA & ASIA.

At the moment I am not 100% sure of South America because the forms I sent them many months ago were returned to me. So to be on the safe side those of you in South America please send your cards direct to me—(Gus Browning, W4BPD, Route 1, Box 161-A, Cordova, S.C. 29039 U.S.A.) Will let you know about South America when I find out about them. In the meantime I am looking for a good DX club down there to act as Certification Club, the same goes for ASIA and AFRICA.

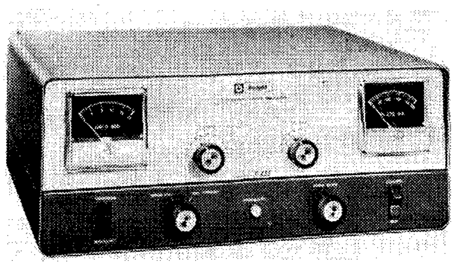
Read the new rules in the November issue (1967) very carefully and start sending in those "extra" cards for our Honor Roll.

In the W T W we have a good thing and I suggest you all jump in, the waters fine!

Gus Browning-W4BPD



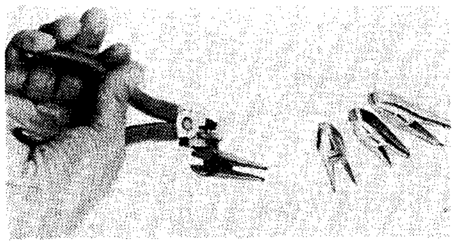
NEW PRODUCTS



Knight-Kit T-175

The new Knight-Kit 6-and-10/11 meter linear amplifier delivers plate power input of up to 300 watts PEP on SSB, 120 watts AM, and 150 Watts CW.

Attractively designed, the T-175 Linear Amplifier is only 5½" high, 13⅛" wide, and 11" deep. The coils are supplied for 26.960-29.700 MHz and 50-54 MHz. The price is $99.95. Sold by Allied Radio Corporation, 100 N. Western, Chicago, Illinois 60680.

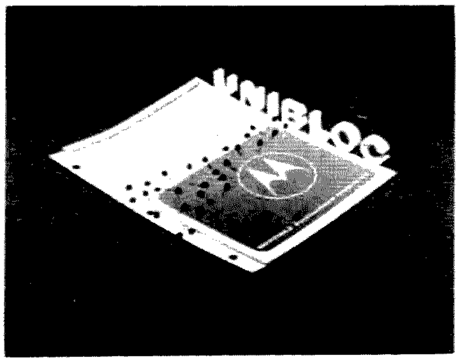


Jensen Swivel-Head Plier Set

A versatile new plier with interchangeable heads which rotate 360° has been announced by Jensen Tools and Alloys.

Using this new tool, the operator can reach easily into inaccessible areas, around corners, into blind spots which cannot even be seen. Eight locking positions are provided at 45° intervals. The new Swivel Head plier thus functions as a straight standard plier and as an angled plier with a choice of eight separate angles to match the work. The set consists of a long nose head with serrations on the gripping surfaces, a shorter duck-bill head with serrations, a duck-bill head with-

out serrations, and a retainer-ring head with pins at the extreme ends. The complete set is furnished in a compact vinyl case and is priced below $15. Catalog number 23C450. Further details may be obtained from Jensen Tools and Alloys, 3630 E. Indian School Rd., Phoenix, Arizona 85018.



Motorola Transistor Selection Guide

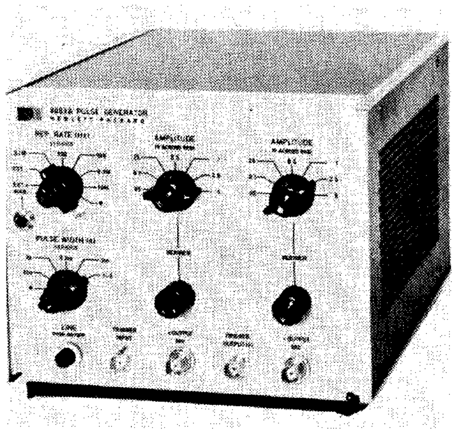
A new complete selection guide for plastic transistors has been published by Motorola Semiconductor Products Inc. The guide covers Motorola's Unibloc silicon annular transistors which have been developed for industrial applications. The guide groups transistor types by application categories and one section of the brochure is devoted to an illustrated description of the Unibloc plastic package. Both NPN and PNP device types are included in this 6 page selector guide. For a copy of the Motorola Selector Guide for Unibloc Plastic Small-Signal Transistors, write Motorola Semiconductor Products Inc., Box 13408, Phoenix, Arizona 85002.

Motorola Thyristor Guide

A handy Thyristor Selector Guide offers an easy to use key to more than 300 different Motorola devices now available for today's modern stepless power control designs. Also included is data on plastic and metal unijunction transistors, plastic bilateral triggers, fast switching SCR's diodes 4-layer diodes and Motorola's practical how-to-do-it thyristor applications guide: the new "Power Control Circuits Library". Copies may be obtained from any Motorola district office, franchised distributor or by writing Motorola Semiconductor Products, Inc., P.O. Box 955, Phoenix, Arizona 85001.

Ameco Model "PT"

The Ameco Model "PT" Radio Frequency Pre-Amplifier, covering the range of 6 through 160 meters, has been specifically designed for use with ham transceivers in this frequency range. Ingenuis control circuitry allows the "PT" to be added to virtually any transceiver without modification. The fundamental requirement is that the transceiver have control circuitry built in for use with an external linear amplifier. The "PT" also contains circuitry to feed and mute a second receiver. It sells for $49.95, complete with built in power supply and connecting cables. Further information is available from the Ameco Division of Aerotron, Inc., Raleigh, North Carolina.

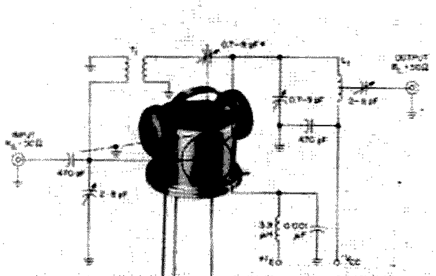


Hewlett-Packard Pulse Generator

This compact, multi-purpose Pulse Generator Model 8003A combines fast risetime (5 Ns) with long pulses (to 3 seconds) useful for testing wideband analog devices such as filters and amplifiers. At the same time, its short pulses (down to 30 ns) and high repetition rate (to 10 MHz) make it well suited for fast switching applications. Optional programmability adapts it to automated test systems as well as serving for lab applications. The price is $470. For further information contact Hewlett-Packard, 1501 Page Mill Road, Palo Alto, Calif. 94304.

Motorola Semiconductors

Low noise, low cost, high power gain germanium transistor solves rf front end needs. The new Motorola MM5000 and MM5002 germanium SME transistors are priced as low as $1.50 and furnish up to 24 db minimum power gain at 200 MHz. Higher frequency, and lower noise performance is obtainable due to complete freedom of transistor geometry and much better definition and closer spacing of emitter/base areas to gain optimum device performance.

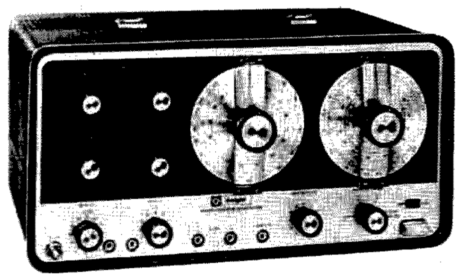


MM5000-MM5002—POWER GAIN AND NOISE FIGURE TEST CIRCUIT

TABLE

Type	Low Noise @ 200 MHz	Power Gain @ 200 MHz	Price (100-up)
MM5000	1.6 dB max	24 dB min	$2.95
MM5001	2.0 dB max	22 dB min	2.10
MM5002	2.2 dB max	20 dB min	1.50

Additional information may be obtained through P.O. Box 955, Phoenix, Arizona 85001.



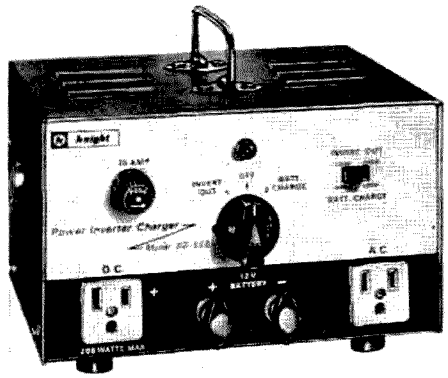
Knight Solid-State Sweep/Marker Generator

The 1968 model Knight KG-687 Sweep/Marker Generator is designed with laboratory quality specifications and covers all TV and FM, *if* and TV-VHF frequencies. It permits complete alignment for Stereo FM, black and white, or color TV, front ends and *if's*. This is a fine instrument for design work, production and testing, maintenance and servicing.

The KG-687 provides an all-electronic sweep up to 18 MHz wide at the highest center frequency. It has a built in crystal controlled and variable post-injected marker for non-distorting markers.

It is a solid-state circuit using all silicon transistors to minimize drift and provide maximum reliability.

The model KG-687 is priced at $120 in kit form, $185 assembled. It is available from Allied Radio Corp., 100 N. Western, Chicago, Illinois 60680.



Knight-Kit Inverter/Charger

One of the most useful of electronic devices is a unit that permits operation of standard AC appliances from a 12 volt battery. Allied Radio now has made available a compact Knight-Kit Solid-State Inverter/Charger, 1968 Model KG-666 which converts 12 volts dc to 110-130 volts ac. It operates ac appliances (radios, TV, transceivers, power tools, lights, shavers, soldering iron, test equipment, etc.) in cars, boats and trailers. It can be used by campers, sportsmen, hobbyists, farmers, explorers—almost everyone, especially since it also charges 12-volt batteries.

The kit is designed for easy assembly and is supplied with complete step-by-step wiring instructions and solder. It is priced at $44.95 and is available from Allied Radio Corporation, 100 N. Western, Chicago, Ill. 60680.

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

Motorola Zener Diode Guides

Easy, quick identification and selection of virtually any Zener or temperature-compensated reference diode is possible with these newly released publications from Motorola Semiconductor Products, Inc.

The 40 page cross-reference guide covers the widest offering of devices in the industry. All Motorola zener, temperature compensated and precision reference diodes, assemblies, current regulators, reference amplifiers, high power transient suppressors, Meg-a-Life, and mil-type units are covered.

The condensed Selector Guide provides a handy, wall or desk mounted key to the more than 6,000 standard, industrial and military application Motorola devices.

Copies are available from any Motorola district office, franchised distributor or from P.O. Box 955, Phoenix, Arizona 85001.

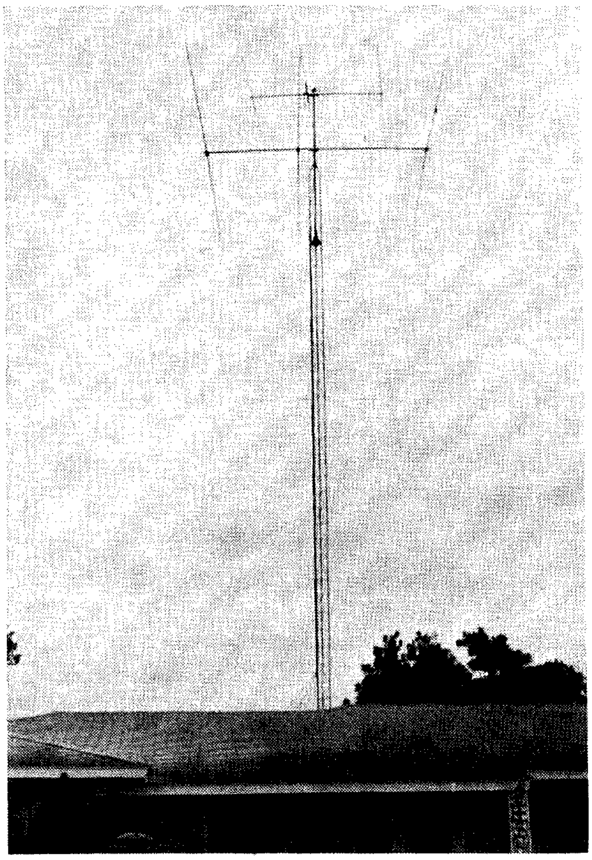
MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

John A. Attaway, K4IIF
and James E. Fredericks, K4ELB
P.O. Box 205
Winter Haven, Fla. 33881

Converting The TA-33 Jr to Full-Power 15 Meter Beam

And It's Use In A Real Crazy Triband Array



During the past sunspot minimum hauling down the old tribander became common practice, particularly among DXers, as first 10 and then 15 meters deteriorated and gave up the ghost. Up the pole in its place went such things as 20 meter monobanders, 40-20 meter duobanders, and even 40 meter monobanders as propagation hit rock bottom. The serious DXers who were not already using linear amplifiers found that high power also became a virtual necessity.

More recently, however, as the sunspot number climbs, 15 meters has begun to regain its old punch, and occasional flurries of 10 meter activity into the southern hemisphere are being experienced. As a consequence, the DXer who ignores 15 is taking a chance on missing some good ones.

This thought was very prevalent while cleaning out the garage a few months ago, when what should turn up but the old TA-33 Jr. It was a good standby antenna and great for field day, but it just wasn't made to handle high power. For those unfamiliar with this beam, it is a lightweight trap tribander of the Mosley family. Its size and weight permit it to be easily rotated by the AR-22 TV antenna rotator. It is rated to 300 watts maximum power input, and consequently is fine for use with Valiants, HT-37s, and most of the SSB transceivers.

The little beam brought back pleasant memories of past contests during the favorable portion of the sunspot cycle. Many times the best single band score was on 15 meters while using the TA-33 Jr for 10, 15, and 20. It seemed to be an unusually good antenna for the 21 MHz band, so for curiosities sake we pulled out the Mosley poop sheet and checked the beam's exact dimensions. The boom was approximately 12 feet in length. When set for fone operation the driven element was 23 ft. 10 and ½ inches, the director 22 ft. 10 and ½ inches, and the reflector 25 ft. 9 and ½ inches. These lengths of course included the traps. It was evident that these dimensions were very close to those of a 15 meter monobander. To verify this we checked the lightweight 21 MHz, 3-element beam described in the ARRL antenna handbook[1]. This beam uses a 15 ft. boom, a 23 ft. radiator, a 22 ft. director, and a 25 ft. reflector. The only difference of consequence between it and the TA-33 Jr was the longer boom on the monobander.

[1]The ARRL Antenna Book, 8th Edition, pg. 253

Other significant measurements on the TA-33 Jr included the 5 foot spacing between the radiator and the director, and the 7 foot spacing between the radiator and the 0.16λ, respectively. According to the ARRL graph relating element lengths and spacing, Fig. 9-24, page 254[1], the director for a 15 meter beam with this spacing should be 464/21.4 or about 21 ft. 2 and ½ in. for operation on 21.4 MHz. From this same graph, the reflector was calculated at 495/21.4 or about 23 ft. 1 and ½ in. while the driven element was 475/21.4 or about 22 ft. 2 and 1.2 in.

Consequently, all that is required in converting a TA-33 Jr to a 15 meter monobander is first the removal of the traps and substitution of aluminum tubing of the appropriate lengths. This is easily accomplished as the traps are mounted on ½ in. aluminum tubing, readily available, and can be taken off by removing only one sheet metal screw. Then a short piece of ½ in. tubing is used to join the two halves of the driven element, and a gamma match is installed. The gamma match used in this particular instance was of a unique design developed by K4ELB and will be described in a later article.

The converted tribander can be easily restored to its original function by reversing the above procedure. The gamma match, radiator connector, and aluminum tubing can be removed and the traps replaced in a matter of 5 minutes time and the TA-33 Jr will again be in service.

The new monobander was placed on a low tower for preliminary testing. It was found to load satisfactorily, and preparations were begun to hoist it up the high tower for stacking over the 20 meter beam. However, at this point it was decided that some provision should be made for 10 meters. After all, the sunspot cycle was definitely on the way up. Unfortunately, there weren't anymore spare beams in the garage, but a 102 inch whip complete with mobile mount was found, and it was reasoned if it were installed above the 15 meter beam, which would be at 73 feet, a pretty fair country antenna for 10 meters would result. Accordingly, the whip was attached to the mast above the beam and installed at the top of the tower. The braid of the 10 meter co-

axial feed line was soldered to the boom of the 21 MHz beam so that the latter could act as a ground plane. This gave us a 10 meter ground plane extending to near 80 feet above the earth, a 3-element 15 meter beam at 73 feet, and a 3-element 20 meter beam at 66 feet. The 20 meter beam consisted of the elements from a Hy-Gain monobander mounted on a 20 foot piece of 2 inch aluminum irrigation pipe for the boom. A greater separation between the beams might be desirable, but the lengths of the mast did not permit a wider spacing. The finished product viewed from the ground is shown on Fig. 1. The whip can be seen faintly as the vertical line above the upper beam. The array is rotated by a Ham-M Rotor mounted inside the tower.

Standing Wave Ratios were determined using a Heathkit Reflected Power and Standing Wave Ratiometer. The 15 meter beam varied from a minimum of 1.3:1 to a maximum of 2.5:1 at the extreme band edge. The 10 meter ground plane varied from 1.7:1 to 2.5:1, while the 20 meter beam was 1.0:1 at 14250 and 2.0:1 at 14.001 kHz.

It is difficult to evaluate the effectiveness of the array through comparative signal reports because of such factors as QRM and band conditions. However, the 15 meter beam has received 5/9 reports from as far east as VS9, VQ9, ET3, etc., and as far west as VK and ZL lands. The 10 meter ground plane regularly received 5/9 + reports from South America and also has a 5/9 from as far away as KS6 land. The 20 meter beam has been used for QSOs with 8F3, XZ2, 1S9, etc., while in phase with the 15 meter beam, so if interaction is occuring between the two bands, it is not serious. Interestingly enough, while the above mentioned contacts were made while running 700 watts power, the 20 meter beam was recently used for a SSB contact with VK2ADY/VKØ on Heard Island while using only the HT-37 barefoot, about 140 watts PEP. This was considered a remarkable achievement in light of the great demand for Heard by DXers, and the poor propagation conditions prevalent during the DXpedition.

. . . K4IIF & K4ELB

Herbert L. Foster
P.O. Box 516
Kalaheo, Kauai, Hawaii

The Scientific Method

Hate filled the room. It seeped, like a thing alive, from the young woman who sat at the desk studying. It crept over the *Radio Engineer's Handbook*, curled around *The Principles of Radio*, eddied about the open *Radio Amateur's Handbook*, dripped past *Basic Mathematics For Engineers* and flowed remorselessly to the floor, where it seethed in murky pools just beyond the small circle of lamplight.

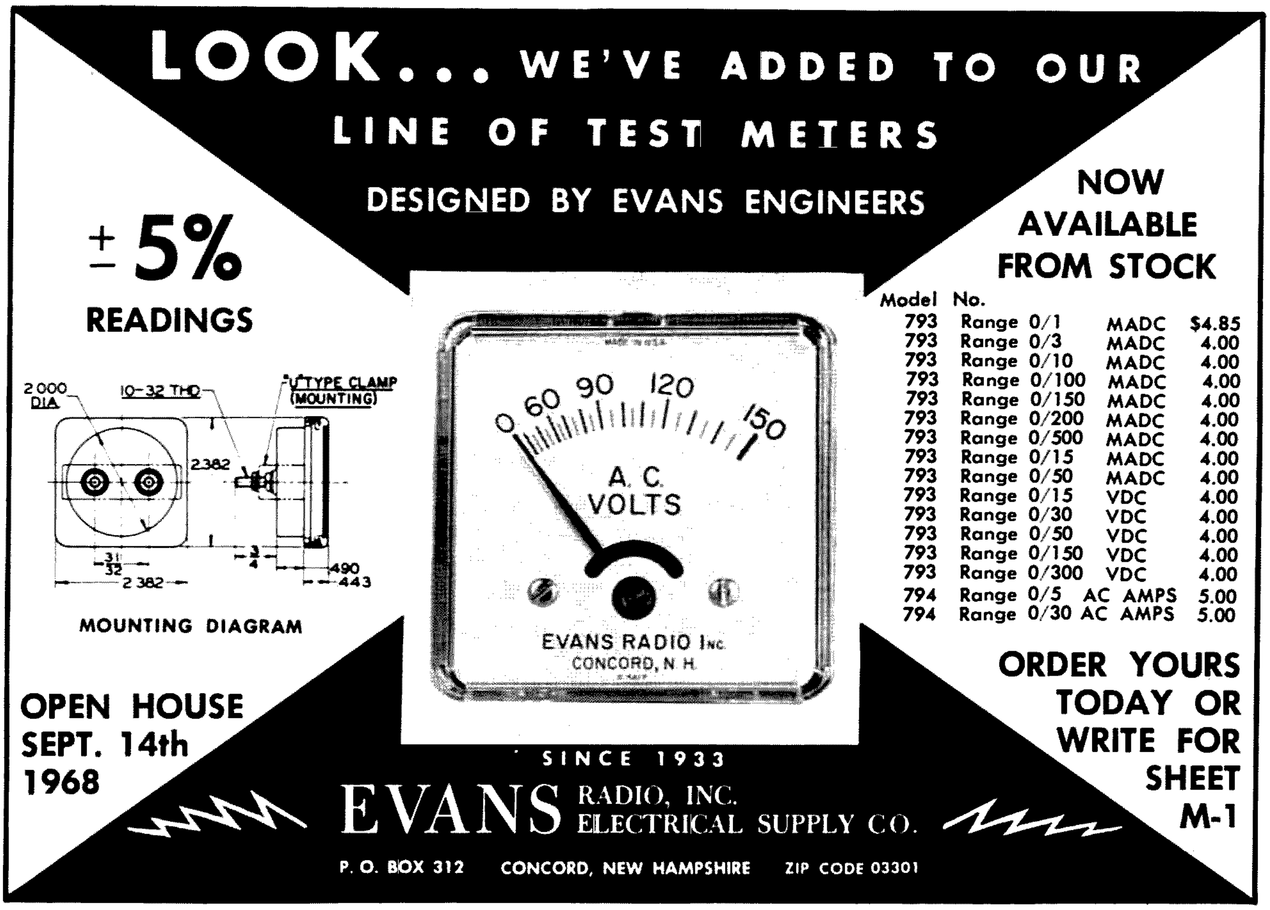
There was a creaking from the chair as the beautiful girl pushed back with a sigh. She put down the slide rule and lifted her eyes to the ceiling to rest. How she hated her husband! She thought for a moment of their wedding day, six years ago, bright with hope. She thought with contempt of how she had been a typical bride, radiant, with stars in her eyes. She had been in love with love itself. Her husband . . . how handsome! What a lovely couple, people had said. How right they were for each other. If ever a marriage was certain to succeed, this was it.

People, she snorted! They didn't know about amateur radio operators. Hams, they called themselves. Pigs would be more like the truth. Dirty, filthy, lazy swine, who wallowed in their welter of tubes, coils of wire, beam antennas, day after day, to the absolute exclusion of all else. How she had tried to interest him in herself, in her own lovely world of knitting, embroidery and flowers. It was a short honeymoon, she mused. It was very likely one of the shortest on record. He'd jumped up, one evening, looking at his watch, exclaiming, "I've got a sked on ten in W2 land!"

After that she'd seen little of him. He had taken to coming home from work night after night and disappearing almost at once into his transmitter room. She'd learned early that hams liked to refer to the rooms where they kept their equipment as "shacks". She thought, with a curl of her lip, how thoroughly right and fitting the term was.

It was difficult to pin down with any degree of exactitude when she'd first thought of murder. It may have started that night when he'd ignored her carefully planned living room, with the dimmed lights and soft, romantic music. He'd then spent the next four hours frantically chasing an elusive radio contact, nearly at the antipodes. Or was it the night she'd met that handsome man at one of her friend's dinner parties? As usual, her husband was in his shack, working with his radio. She'd been forced to attend the party alone, where her hostess had paired her off with a charming attentive man. Perhaps it was then she had first realized with crystal clarity that her husband must go. That which she had to offer the world, her youth and beauty, were still highly negotiable assets, and if her husband didn't appreciate these qualities, here was one man who obviously did. Of course, she realized, one cannot just go around murdering people. The trick is to get away with it. For that matter, murder would not even be necessary if her husband would only listen to reason. He'd made it quite clear that he did not believe in divorce, and would never, under any circumstances, even consider it. Have it your own way, she'd thought grimly, and begun to ponder a suitable method. Just any old way would not work. This would definitely require what her husband fondly called the scientific method.

She'd started to study radio, sneaking his books when he was away, at first, burrowing, probing into the mysteries of electronics. Radio involved electricity, and that was dangerous, wasn't it? After all, didn't they execute murderers by electrocution? There must be some way to safely eliminate her ham of a husband; some scientific method hidden in those weighty tomes. He'd actually delighted when he'd first come upon her with her nose in the *Handbook* and had been most helpful. There had followed weeks and months of study, and at last she'd found



the answer! Not that there was a chapter carefully labelled, "How to Murder Your Husband", but just the same, the information was there.

She dropped her eyes once more to the open textbook before her, smiled faintly, and then, closing the books, piled them neatly. She snapped off the student's lamp and walked into the kitchen and began to brew some coffee.

She went carefully over her plan as the water heated. She took delight in her new ability to think in technical terms. Without the bleeder resistor across the output of the high voltage power supply, there would be nothing to remove the death dealing voltage from the final filter capacitor following its shutdown. If her husband could be caused to turn on a unit defective in this manner, and then it off again. . .

With infinite care, she had fashioned the trap. The bleeder resistor, with its open circuit, made to look like a natural break; the open cathode lead on the power amplifier; the faulty ground rod; and the last critical link in the plan, provided by her husband himself. The train of events was predictable. He'd tune up the transmitter on high power. He would see plenty of drive on the final grid, with no plate current. He would shut down the transmitter, give the final plate a hasty swipe with the defective grounding rod, and then grab the plate cap of the final stage with his hand. The loaded capacitor would do its job. The plan was good. Nodding thoughtfully, she was satisfied.

Her head lifted as she heard the car turn into the driveway, and she began to pour two cups of coffee, finishing just as the kitchen door burst open, and her husband strode into the room. There followed a hasty peck at her cheek, as he grabbed some coffee on his way to the shack. The wife sat down and waited. Suddenly the house echoed to a crackling WHAP!, a queer choked yell that ended even as it began, and the heavy thud of a 160 pound body hitting the floor. The widow smiled.

The crackle of static filled the room, as the girl leaned back in her chair for a moment. She lifted her eyes past the short wave receiver, swept by the exciter, passed briefly over the kilowatt amplifier, and rested near the ceiling where the black snake of a coax cable went through the wall. Her memory drifted back over the past year. How so-

licitous her friends had been. She'd made a lovely widow, playing to perfection the part of the bereaved spouse of a man electrocuted by his own transmitter. After a decent interval, she'd begun to accept invitations. It was at one of these affairs that she'd met the handsome, attentive man again. She'd been right; he was interested. So interested, in fact, that he was at this moment sitting in the living room as her new husband. Strange, she thought with an inner chucke, but her studies of radio had born fruit in another, totally unexpected manner. She'd felt her curiosity touched and had gone on to obtain her own license. She leaned forward and began to make delicate adjustments to the transmitting apparatus.

In the living room, her new husband sighed as he turned to page 37 of the *Radio Engineer's Handbook*. There were dark thoughts of murder in his heart. ■

W1EMV from Page 2

are reviewing a piece of equipment with which a member of the staff is familiar, it may be acceptable. The reason for this is that a review in 73 gives our approval to the equipment and if it turns out to be a poorly designed device, we get caught in the middle. I would be interested in hearing from anyone who is doing work with multiplex. This is obviously the next breakthrough in use of frequencies, and should be examined.

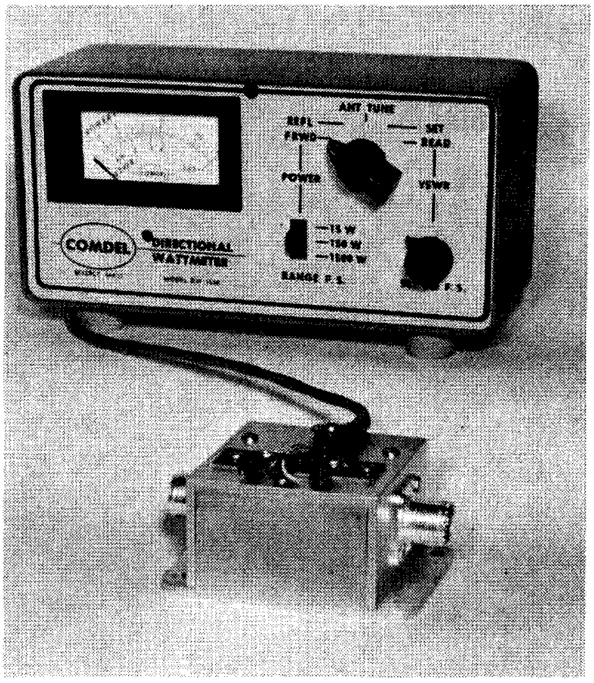
Fiction, humor, and the "Look what happened to me" type of article is the least in demand. If it makes *me* laugh, I'll buy it, but I'm hard to please. Satire on some of the foibles of ham radio is good (see S-9-Manship on page 56) and can be used to deliver a message.

The important thing is, if you have recently built a new piece of gear and have it working on the air, let the rest of the world know about your project. Photos and diagrams are a must. An article without them is dull and readers often pass them up. You don't have to be an artist, though. We have a fine draftsman who will redraw all your diagrams to our specifications.

I'll be waiting to hear from you. Reading manuscripts is my favorite pastime in the evenings . . . well, maybe not my *favorite* . . . but it is better than TV.

. . .W1EMV

Comdel Wattmeter DW 1550



Recently, I had the opportunity to try out Comdel's new wattmeter and was impressed with its versatility and accuracy. Like other devices of the same kind, it is an "In-Line" instrument, which consists of two separate parts; an rf coupler and a meter unit. The coupler is inserted in the outgoing transmission line, while the meter unit which contains all controls, may be placed in any position suitable to the operator. A three conductor cable, furnished by the supplier, interconnects the two units. Provision is made to bolt the two units together to form a single entity, for those who find this more convenient.

In contrast to simple SWR indicators, the Comdel instrument measures true power up to 1.5 kW, over the frequency range of 1.5 to 60 MHZ. A range selector permits full-scale deflections of the meter for outputs of 15, 150, and 1500 watts. Forward and reflected power are measured, as selected on the function switch, and the absolute power output is, of course, the difference between the two. When the system SWR is less than 2:1 the reflected power can be ignored

The Comdel unit doubles as a VSWR bridge. The use of charts based on forward and reflected power is eliminated by two more positions on the function switch, SET and READ, and a separate VSWR scale on the meter. A separate control knob enables the user to set the meter to full scale in the usual manner. This control is out of circuit when power measurements are being made.

A very useful feature is provided when the function selector is placed in its center position, labelled ANT. TUNE. If you have been tuning external antenna couplers for minimum VSWR, you may on occassions have ended up, as I frequently have, with zero reflection but also with no output. This condition is not exactly good for your equipment. The danger is completely eliminated when the Comdel instrument is used in the ANT. TUNE position. The meter indicates the combination of forward and reflected powers, and the antenna tuner is simply adjusted to give maximum meter deflection.

The meter unit is attractively styled and measures 7½" long by 4" high and 3½" deep. The coupler is of rugged construction and features mounting holes for permanent attachment to bulkheads or any convenient surface. The price is $95.00 postpaid in the U.S.A. ■

Comdel Inc., Beverly Airport, Beverly, Massachusetts 01915.

DW 1550 Specifications

Frequency range:	1.5 to 60 MHz.
Power range:	0.2 to 1500 watts.
Power accuracy:	± 1 dB.
Impedance:	51 ohms nominal.
VSWR range:	1.0 to 4.0:1.
VSWR residual error:	1.1:1 maximum from 1.5 to 60 MHz. 1.05:1 maximum from 2.5 to 30 MHz. Negligible from 3.5 to 25 MHz.
Insertion loss:	Negligible.
Size and weight:	7-9/16" x 4" x 4-1/4". 20 oz.
Price:	$95.00.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

W2NSD from Page 4

self as a committee of one to try and correct him. Explain to him that America already has enough problems with our image abroad without his reinforcing the idea that we are inconsiderate and immature. Be as nice as you can about it and be ready to hold your temper because the other chap will probably get mad. Almost all of us get mad when we are wrong and it is pointed out. It is much easier to get mad than to face the thought that we have been guilty of acting stupidly or childishly.

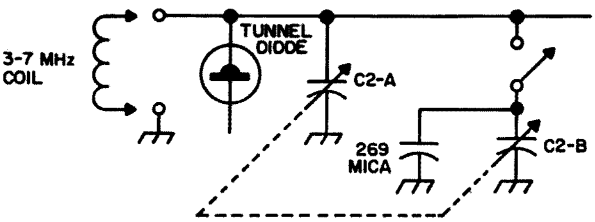
Knowing that the way of the reformer is a hard one, it is a lot easier to not become involved. If you keep quiet all you have to face is your own conscience, and that has taken such a beating already that another black mark won't show. Right? Those of you with consciences that are still reasonably intact have a mandate, I believe, to help clean up our bands. Even the hardened cases of ego bordering on insanity that manifest themselves will, in time change. Fortunately, most of our troubles stem from thoughtlessness rather than deep-seated neurosis and just a few verbal slaps on the wrist will bring long range benefits.

Well, if anyone goes along with that idea, we may be on our way toward a long range improvement in amateur radio, not only for ourselves, but in the image we project to foreign amateurs and to radio Administrations around the world. I hope that the idea takes hold enough so that our next problem is to find a way to protect ourselves from the self-appointed protectors of our image.

Our DX bands are badly crowded at times and it is normal for there to be some abrasion. Rare DX hunting can be very abrasive. There is no point in trying to explain to the fellow who has been calling a rare station for three hours that it is of no possible signifiance in the long run whether he gets through or not. Reasoning with a DXer on the scream is about as fruitful as reasoning with a pit full of vipers. But we can get our 2c in with the chap who calls CQ on a net having neglected to find out if the channel is busy. We can try to calm down some of the more excited fellows who are sounding off. We can ask that blue material be kept off the air. There are lots of things to talk about without getting down to dirty jokes and thinly disguised innuendo.

. . . Wayne—

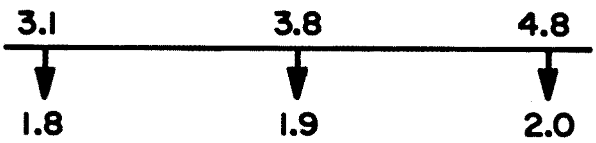
Tunnel Dipper on 160



The Health Tunnel Dipper has been a very useful piece of test gear in building home-brew projects, but the frequency range does not extend low enough for coverage of the 160 meter band. An attempt to lower the range by increasing the inductance ended in erratic operation before 2 MHz was reached.

Operation on the 160 meter band can be accomplished by adding 267 pF of capacitance from the variable capacitor, C2B, to ground, when using the 3 to 7 MHz coil. This capacitor should be a silver mica as disc types cause severe frequency drift. The capacitor may be stored in the coil rack and soldered into the circuit when 2 MHz coverage is needed. An approximate scale conversion when using the 3 to 7 MHz coil and the additional 267 pF is as follows:

For convenience the new 160 meter scale may be pencilled in on the bottom of the 3 to 7 MHz scale.



Carl D. Pleasant, W5MPX/5
218 John Wayne Dr.
Lafayette, La. 70501

Questionnaire

We don't like things to be static at 73, so, although the magazine gets few complaints, except for occasional circulation problems and some of the opinions expressed in the editorials, we are always thinking about improvements that might be made.

You can help a lot with this, if you will. Just tear out the questionnaire below and send it to us, suitably marked.

For instance, do you find the propogation charts of value and do you think we should continue them? These are expensive to prepare and take up a half page every month so if you don't really want them we could publish just that many more articles.

How about the placing of the advertising? We try to spread it through the magazine to give the best opportunity for you to see what is being advertised rather than jamming it all up in a solid bunch the way QST does. CQ used to do that too, but they have changed over somewhat to our system now and have spread the ads out a bit.

What about color? We can easily put full color pictures on our covers if you like them . . . and if you send in pictures for us to use. Do you think we should run a second color all through the magazine the way CQ is doing now? This would be simple for us to do, but we have refrained because we think it looks junky and cheap . . . what do you think?

And what do you think about unsigned editorials such as CQ has been running? How do you feel about unsigned editorials? Shall we?

Now that QST has suddenly discovered transistors perhaps we are giving you too much transistor dope? Would you like more of as emphasis on tubes or should we continue to stay ahead of the other magazines with new transistor info?

A few readers complain, though I'm not sure they are serious, that it takes too long every month to read all the articles in 73. Of course we do run more articles than the other two magazines combined as a rule. but we thought you liked that.

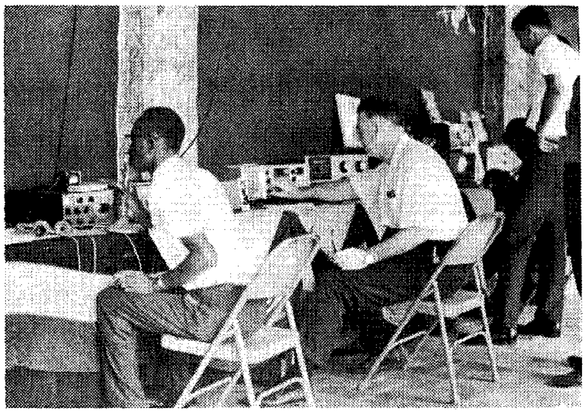
Tear out and return to 73 Magazine, Peterborough, N. H. 03458

	YES	NO
Do you regularly use our propogation charts?	☐	☐
Do you read the ads in the front of QST regularly?	☐	☐
Do you read the ads in the back of QST regularly?	☐	☐
Shall we continue to spread the ads through 73?	☐	☐
Would full color covers make a big difference to you?	☐	☐
Should we splash color all through 73?	☐	☐
Do you approve of unsigned editorials as in CQ and QST?	☐	☐
Would you prefer more tube circuits than transistor?	☐	☐
Should we make 73 smaller and limit advertising?	☐	☐

Field Day in Liberia

The Liberian Amateur Radio Association will hold its annual field day March 30, and 31, 1968. Plans are presently underway to make this year's Field Day the biggest and largest ever. Last year the club used the new call designation 5LAFD and caused several large pile-ups.

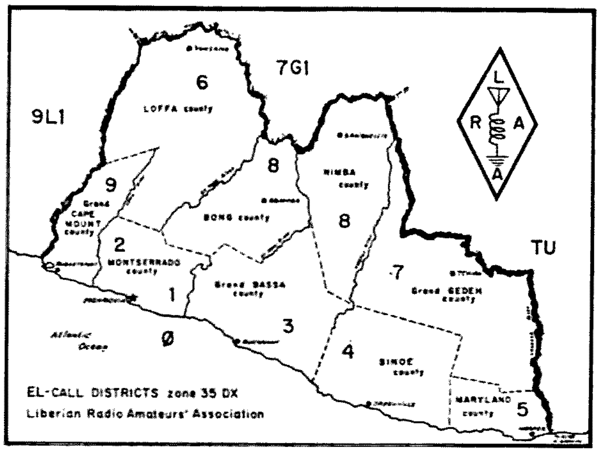
This year's annual field day should provide as much excitement with another special issued call, 5Z2RL. Plans are to have more equipment and operators working during the 36 hour field day which will begin at 1200 GMT March 30. A new addition this year will be the introduction of RTTY operating in the 15 and 20 meter bands. CW, and SSB Phone operation will be in 10, 15, 20 and 40 meter bands. For those persons interested in collecting rare or unusual QSL cards be sure and contact 5Z2RL on March 30 and 31.



The Liberian Amateur Association has received world-wide recognition and has received guidance, equipment and support from other amateur clubs. Equipment donated by various clubs, organizations, groups, manufacturers, and individuals is being set up in schools through-out the country. The majority of the clubs membership is made up of foreigners from many different countries.

In an effort to introduce the local population to amateur radio a country wide training program has been implemented. This training has begun to bear fruit as more and more Liberians begin to obtain licenses and show a real interest in this worldwide society.

The Liberian government has given its full suport and backing to the association. On field days the Government of Liberia has provided speakers and words of encour-



agement. In the past, the Amateur Association has provided emergency standby communications whenever the president visited remote areas of the country. At fairs and on many different occasions the association provided communication booths and equipment displays.

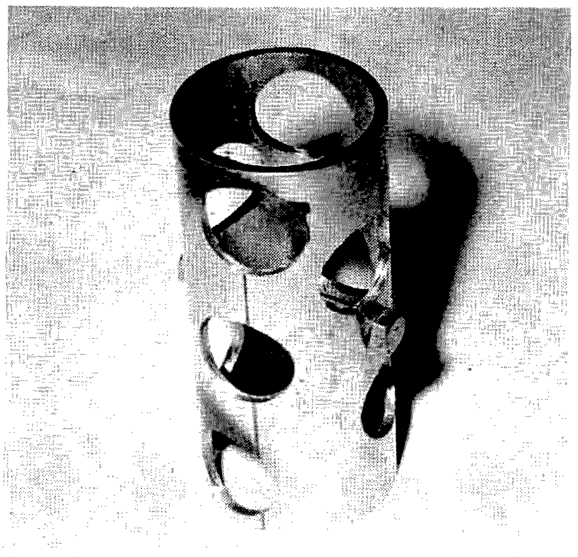
The association also issues a very attractive certificate to any amateur who works nine of its ten call districts. To be eligible for this certificate amateurs who have worked nine of the districts within the past three years or works them in the future must send the nine QSL cards to the Secretary of the Liberian Amateur Radio Association for verification. ■

SOME NOTES ON OUR

REGINAIR 321 QUAD

Perhaps you too looked at the familiar "H" pattern of the conventional 3 band quad and wondered how acceptable performance could be had from such a configuration. To Larry Johnson, WA1BUN, this concept was all wrong for the electrical spacing between elements varied widely and obviously the resulting terminal impedance of the driven elements varied equally. Trying to connect one feed line to three different impedances is touchy and mechanically difficult. The outcome, it was reasoned, was a constant electrical spacing for all three bands. This was achieved in the Reginair Quad by means of a spider type design, the hub for which is illustrated here. Eight inches long, 3½ inches in diameter, and a thick ¼ inch wall give ample mechanical support to the four aluminum tubes, which in turn support the insulating dowels. This aluminum hub is drilled to accommodate up to 1¾ inch diameter masting, to which the hub is fastened with a ½ inch plated steel bolt.

Constant electrical spacing resulted in a terminal impedance on each band of 100 ohms. This is transformed down to 52 ohms by a Q section of RG11/U cut for 21 megacycles (when matching 2 to 1, a Q section works very well over the octave from 14 to 28).



The bugaboo of suck-out, caused by 10 meter radiation from the 20 meter element, has consistently plagued Quad builders, for VSWR invariably jumped on 20 meters—the very band where we wanted the flattest response. After many trials, Mr. Johnson resolved this problem by inserting a quarter wave 10 meter shorted decoupling stub made of RG8/U, within the 20 meter driven loop.

No baluns need be used with the Reginair 321 Quad. The Quad is a full wave device, not a half wave. As a result, the RF currents from both the sheath and the center conductor of the feed balance out and no balun or balancing device is needed. You can prove this with 2 RF ammeters. In other words, the Reginair Quad is self-balancing; it is, in effect, its own balun.

Previous quad design used stubs or other devices to achieve low VSWR. Our Quad needs no adjustments of any kind—no loading coils—and yet reflects less than 1.5 to 1 VSWR over the entire 10, 15, and 20 meter bands. This most important feature is obtained by making the reflector loops very slightly larger, tuned to a slightly lower frequency.

The measured gain of this Quad is 5.9 db, compared to a conventional dipole; 8.5 db as compared to an isotropic dipole. The front to back will be 25 db equivalent to an average of 4 S units on a typical receiver.

This Quad is quickly assembled from a complete package with pre-assembled driven and reflector elements. All you need do is furnish the 52 ohm feed and raise it into position. A light TV rotator, such as the AR22R ($33.95) will swing it easily. The completed Quad weighs but 35 pounds and requires 19 feet of area, or 9½ feet of radius.

The most salient feature of our Quad is its flat response. This is particularly important because most hams today use transceivers or transmitters that can accommodate only VSWR of up to 2.5 to 1 at the most. Consider your finals and the longevity of their life, and you can see why. In a typical illustration, a pair of 6HF5's are employed as finals in a transceiver with a 400 to 500 watt PEP rating. The tubes themselves are TV horizontal oscillator types, with a dissipation rating of 30 watts each. Sixty watts then is the most you can tolerate. The idling current of the finals is 50 mills times 800 volts or 40 watts. At 2.5 to 1 ten per cent of the forward power is coming back to roost. With 250 forward watts from our transceiver, 25 watts are returned. Twenty-five and forty equal 65 watts—5 more than should be considered safe. As you slide up and down in frequency, think of what is happening in your rig—unless you had the good judgment to operate at your antenna's resonant frequency, or better yet, the wisdom to use our Reginair Quad where the VSWR is guaranteed to be less than 1.5 to 1.

Remember too, a quad has more than twice the capture area of a similar rated beam. In the case of the 321, more than 350 feet of wire are used.

To you doubting Thomases, read what WØKHI had to say. "I want to add my name to the many satisfied users of your new Quad. This is the first Quad kit that I have purchased that was a 'true' kit and not simply a do it yourself bunch of quad parts to homebrew. All the parts used in your kit are of good quality and well put together; the wire used is especially appreciated for ease in Quad assembly. It does give me for the first time an SWR that pleases me; it is between 1.2/1 and 1.0/1 on all bands."

The Reginair 321 Quad is available in 3 models. The standard models sells for $79.95; the APO model is $99.95; the deluxe version is $129.95. The standard model uses hardwood (bass wood) dowels; the APO model is similar except that it is cut down so that it can be mailed via parcel post to any APO post office and is furnished with clamps and sleeves so as to restore the original length; the deluxe version is a fiber glass version, which will be available after April 1st. All the prices quoted are FOB Harvard, Massachusetts. Delivery can usually be accomplished within a week from receipt of your order.

HERBERT W. GORDON COMPANY

Woodchuck Hill Road • Harvard, Massachusetts 01451

"Helping Hams to Help Themselves"

Getting Your Higher Class License

A new approach to studying for the Advanced and Extra Class Licenses

Part I — Radio Wave Propagation

Effective last November 22, the FCC once again made available the Advanced Class license. At the same time, the examination for the Extra Class license was revised. Several sets of "study questions" covering these new examinations were released.

A number of firms are preparing study manuals based upon the new questions. If past experience is any guide, the resulting study manuals will provide specific answers to the specific questions together with just enough "general" material to permit similar questions to be answered—but won't appreciably increase the amount of generally applicable technical knowledge possessed by their readers. Such a procedure is adequate if the intent is to permit applicants to memorize enough answers to pass the examinations; it does little or nothing to raise the level of technical knowledge in general. Since the past "study questions" have included the actual questions used on the exams. memorization works.

We think, though, that the whole idea of re-structuring the ranks of ham radio was to improve the general level of technical knowledge. Memorization won't do that—understanding is required.

With this article, therefore, we're initiating a series of articles which will split the 51 "study questions" released by the FCC for the Advanced Class exam into 10 groups, each dealing with one or more general subjects. These subjects will be explored in sufficient detail to provide all the technical knowledge necessary not only to answer the specific study questions, but to make use of their content for any purpose you desire.

We *won't* give you an answer to memorize. we *will* show you how to figure out the answer for yourself. You can then handle any question on the subject. Okay?

Our choice of questions to be discussed in any single article is based on the general subject covered by the question rather than on its numeric order in the study lists. However, we're including its number as as well, so you can relate the articles to the original list if you like.

In this initial article, the subject is "radio wave propagation", which is covered by the following five questions from the study list:

6. What factors affect the state of ionization of the atmosphere?
14. Define maximum usable frequency.
35. What is meant by describing a radio wave as horizontally or vertically polarized? Which type is most suitable for sky and ground wave propagation?
36. Which amateur band is the most usable for daytime communication over a distance of about 200 miles?
47. How does the sunspot cycle affect wave propagation? What are the best frequencies to use for day and night, short and long distance communications during the cycle?

Let's get under way by substituting a group of general questions for these specific ones, and looking for the answers to our new group of general questions. If we find the answers we're looking for, then they should include the answers to these five specific questions—and much much more.

Before we can say much about the propagation of a radio wave, we need to know what a radio wave amounts to in the first place. Therefore our first general question becomes "What is a radio wave?" The second follows immediately, since our subject is the propagation of this wave: "How does a radio wave propagate?" or more compactly, "What is propagation?"

All five of the specific questions deal in some manner with the relation between the "ionization of the atmosphere" and radio wave propagation. That phrase "ionization of the atmosphere" is a bit repugnant to physicists, since the ionization layers are generally considered to be rather far above the atmosphere. The more common name for the layers about which we're going to talk is "ionosphere", and our third general question then becomes "What is the ionosphere?" while the fourth follows directly "How does the ionosphere relate to radio wave propagation?"

The fifth of our general questions is also implicit in the third but is not quite so clearly related: "What is the relation between the ionosphere and the sunspot cycle?", or more generally, "How does the sun affect the ionosphere?"

We'll move ahead only after warning you that if anyone could give absolutely accurate and definitive answers for these five general questions, he would be a greater genius than Newton and Einstein together. Any *one* of our general questions leads directly to the core of all science—the question "What is existence?" However, we'll shy clear of the attempts to reach exact details, and explore the questions only as deeply as necessary to obtain knowledge which *works.*

What Is A Radio Wave? Nobody has ever seen a radio wave, nor can anyone describe such a thing except by means of complex mathematical expressions which serve primarily to obscure the fact that no one knows what a wave is, or even if it exists. For our purposes, fortunately, we can describes a wave accurately enough by saying that it is a pair of crossed electric and magnetic fields, in motion from somewhere to somewhere else.

This naturally leads to the question "What is a field?", and if you ask a physicist you may lead rapidly to the feeling that it is just another name for half of a wave. While in the strictest sense this is true—a field cannot be measured except by the effects of the waves of which it is a part —you can visualize both electric and magnetic fields accurately enough for almost all ham radio purposes by thinking of charged capacitors and bar magnets.

A charged capacitor contains a trapped electric field. Imagine that the capacitor is perfect—no leakage—and it's not too difficult to realize that, once charged, it will retain that charge indefinitely. Unfortunately, the charge isn't of much use so long as it's being held by the capacitor; it can only do work for us if it's in motion. The HV filter capacitors in your power supply are perfectly safe—until you touch their terminals. *Then* they bite, as the trapped charge rushes out—cooking your fingers (and maybe you as well) on the way.

Similarly, a bar magnet contains a trapped magnetic field. A really good magnet will hold its magnetism almost indefinitely, just as a good capacitor will hold its charge. Like the charge in the capacitor, the magnetism of a magnet doesn't do much until it reacts with something else.

Both these examples provide images of "static" fields, which is simply physics-ese for fields which aren't going anyplace. While it's difficult to get much visual picture of a static electric field, you can see the general appearance of a static magnetic field by placing a magnet under a sheet of paper and sprinkling iron or steel filings on top. The filings align themselves with the field, something like the pattern shown in **Fig. 1.** The exact pattern will de-

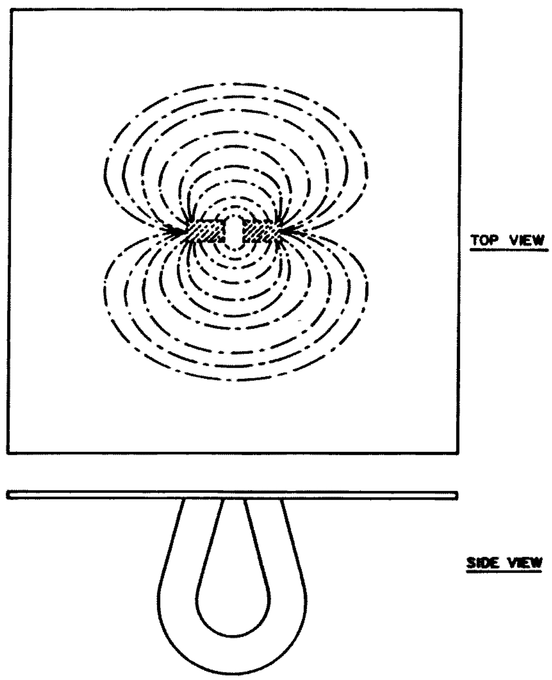


FIGURE 1. Pattern made by iron filings sprinkled on paper atop horseshoe magnet illustrates magnetic field. Electric field is similar but not so readily illustrated.

pend upon the field of your own magnet, and this depends upon the magnet's shape.

Magnetic and electric fields are similar to each other in many ways; so similar, in fact, that many physicists believe they are simply two effects of the same (unknown as yet) basic cause. A fact lending strength to this belief is that either of them, when it moves, is immediately accompanied by the other. You can prove this if you like by charging a capacitor to get a static electric field, then winding a small coil of wire around a pocket compass. Connect one end of the coil to one terminal of the capacitor and then, while watching the compass, complete the circuit with the other end of the coil. As the static electric field moves along the wire, you will see the compass needle kick; the only kind of field which can affect the compass, however, is *magnetic*.

If we have a clear enough picture of what static fields are like, and are willing to accept the idea that each of them carries the other along when it moves, we're ready to take a look at a wave.

Fig. 2 shows a highly simplified version of one way to imagine a wave. The solid curve, which represents a sine wave in the vertically-aligned plane, corresponds to the intensity and direction of the electric field at any instant. The dotted curve, which represents a sine wave in the horizontally-aligned-plane, corresponds to the intensity and direction of the magnetic field.

While a field's intensity can vary at any rate, not just as a sine wave, the only kind we're interested in *is* a sine wave.

The important things about **Fig. 2**, are that the electric field is represented by a curve in just *one* plane, and that the magnetic field is represented by a curve in a

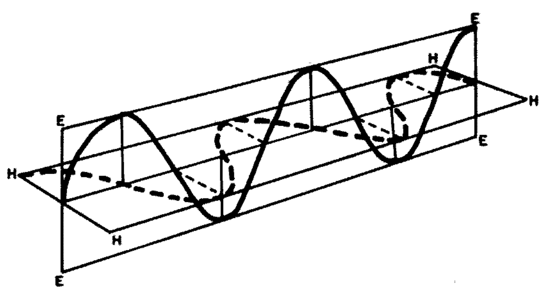


FIGURE 2. Illustration of one way to think of a radio wave. Solid line represents electric field, dotted is magnetic.

second plane which is at right angles to the first. This doesn't mean at all that the fields themselves look anything like this sketch—just that the ideas shown in the sketch have turned out to be useful in predicting how a field is going to affect anything it happens to meet!

One more thing is most important: When the electric field intensity is zero, the magnetic field is at its strongest, and vice versa. Another way of putting this is to say that the electric and magnetic fields are 90 degrees out of phase with each other. This is the characteristic of any wave *in motion*. With the relationship shown in **Fig. 2**, the wave is moving from lower left toward the upper right, or away from us.

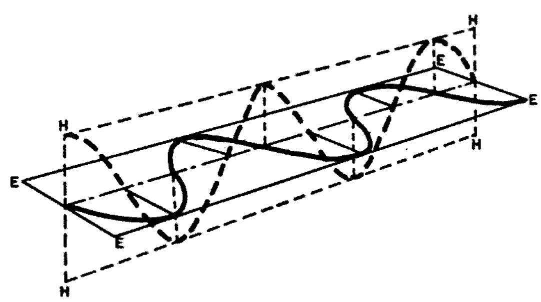


FIGURE 3. Same radio wave as shown in Fig 2, rotated 90° clockwise to change polarization from vertical to horizontal. Relationship of fields remains the same.

To generate such a wave, we could use a half-wave dipole antenna. For such an antenna, the electric field would be in the same plane as the antenna elements. Thus, the wave shown in **Fig. 2**, is a vertically polarized wave since its electric field is in the vertical plane.

This business of "polarization" is relatively simple if you just keep in mind that "polarization" refers to the plane of the electric field, and that with conventional wire or tubing antennas the wire or tubing of the antenna is always in the plane of the electric field.

To make a horizontally polarized wave out of our sample, all we need do to it is rotate it a quarter-turn to the right as shown in **Fig. 3**. Now the electric-field plane is horizontal and the magnetic is vertical—but the relative phase of the electric and magnetic fields has not been altered.

There's just one more point we need to look at to complete our examination of the radio wave itself before we go on to our second general question. That point is the

manner in which the energy transfers from magnetic to electric field and vice versa as the wave travels.

First think back to our capacitor-and-magnet picture of static fields. Then replace the magnet with a coil, which concentrates the moving magnetic field into a fairly good imitation of a static field for short periods of time. Connect the coil and capacitor together as shown in **Fig. 4**, and surprise! we have a resonant circuit. In this resonant circuit, any energy originally put into the circuit is first stored in the capacitor as an electric field, then flows back through the coil which stores it as a magnetic field, and so forth until the energy all leaks out.

The same thing happens with our radio wave in motion, and that's why the electric and magnetic fields have to be 90 degrees out of phase with each other for the wave to travel. When the electric field intensity is zero, the magnetic field is at maximum. As the magnetic field starts to decrease in intensity, the electric field intensity starts to climb. When the magnetic field reaches zero, the electric field intensity is maximum.

Remember that there's only so much energy bound up in this pair of fields, and the criss-cross from magnetic to electric field and back makes a little more sense. At any one instant, the total energy in the wave remains constant. Whatever of this total is *not* in one of the fields, is in the other. **Fig. 5** shows this effect. Students of physics or mathematics might want to call the lines with arrowheads on them in this picture "vectors", but that's not what they actually are. They're just lines with arrowheads indicating the direction of the lines. The lines in the E and H planes give an indication of the fact that the energy in the wave is always the same, while the corkscrew solid line traces the tip of this energy total at every point in the wave shown. The dotted line, where the E and H planes cross, indicates the apparent location of the "center" of the wave as it travels.

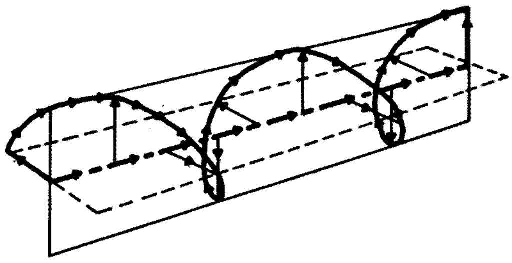


FIGURE 5. This corkscrew pattern shows swap of energy from magnetic-field plane (horizontal here) to electric-field plane (vertical) as wave travels through space. Each radio wave contains an infinite number of such swapping fields, forming an ever-expanding sphere.

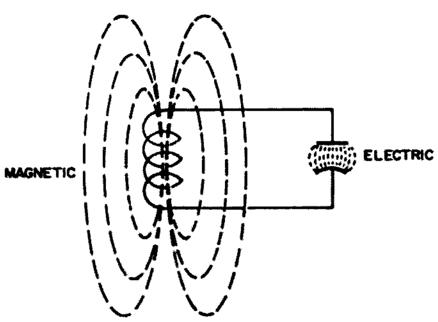


FIGURE 4. Familiar resonant circuit consisting of coil and capacitor is one example of energy swap between magnetic field (of coil) and electric field (in capacitor). Radio wave is similar, but fields are distributed throughout space rather than being concentrated by coil and capacitor.

All of this explanation is greatly simplified, because in practice we don't deal with just one wave. We have an infinite number of them, all overlapping each other, and every time one of the "center" lines happens to hit either a conductor or an insulator a whole new infinity of "scattered" waves is the result. For practical purposes, however, you now have as accurate a picture of a radio wave as you're ever likely to need—and more than enough for the license examinations.

What Is Propagation? A few paragraphs back when we were looking at the continual swap of energy from the magnetic to the electric field of a wave and back again, we were actually looking at the answer to this question. Since the wave itself actually consists of the effects of the two crossed fields, and its motion comes about by the swap of energy between one and the other, the energy swap itself provides the mechanism for propagation.

To get it all started, however, we must get the fields going in the first place. To

do this, we normally need some type of antenna.

Amazing as it may seem, an antenna is merely a conducting surface which is large in comparison with the wavelength involved. Wavelength, incidentally, is the actual distance along the centerline or "ray" of the wave from one peak or null in field intensity to the next similar peak or null. Frequency, on the other hand, is the number of such peaks or nulls which pass a specific point in a specified period of time (usually one second). Frequency and wavelength are related only by the speed with which the wave travels. Since in most cases waves travel at very nearly the speed of light, the familiar conversion formula (wavelength = speed of light/frequency) works. If the wave is going slower or faster, though, it won't.

On such a conducting surface, any change in electric field strength (voltage) or magnetic field strength (the results of current) at one point won't be reflected instantly at all other points, but must travel along the surface. This means that a sudden change from no voltage to high voltage at the feed-point of a half-wave dipole antenna won't change the voltage at the ends instantly. The voltage change will travel from the center toward each end. If one conductor has gone positive and the other negative, the positive voltage point will be travelling out along one half of the antenna while the negative point will be travelling out along the other. Between these two points will be an electric field— and since we know that the voltage will eventually reach the tips of the antenna, this field must be in motion.

In fact, the field is approximately a sphere in this case, and is expanding like a toy balloon being blown up.

But whenever a field of one kind moves, one of the other kind immediately accompanies it. Although we apparently did nothing to cause it, a magnetic field is also in motion around our antenna.

Actually, we *did* do something to cause this magnetic field. As the voltage change moves outward toward the tips of the antenna, current must flow right along with it. The early experimenters wern't very far off base when they spoke of the "charging current" or thought of their antennas as large capacitors. This current is intimately related to the magnetic field in the same manner that chickens and eggs are related; it makes little difference which causes which so long as we admit that we can't have one without the other.

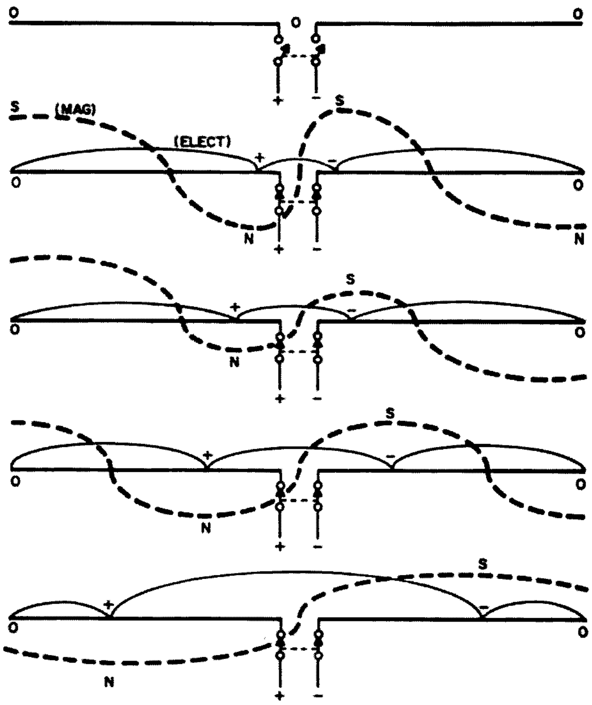


FIGURE 6. Various steps in propagation of radio wave from an antenna are shown here. At top, no fields exist around antenna because switch is open. When switch is closed, points of stongest electric fields (X) begin travelling towards ends of antenna. Solid lines show electric field intensity and dotted lines represent accompanying magnetic fields. Magnetic field lines which sweep off ends of antenna radiate outward into space. Each cycle of RF generates a new maximum-field condition which radiates.

When the voltage change reaches the tips of the antenna it has no place else to go. This halts the current flow and reduces the magnetic-field intensity to zero. However at this instant, the electric field has its greatest intensity, since the positive and negative points are at their greatest physical separation. This produces the 90-degree-out-of-phase condition required to impart motion to a *wave*; up until this time, we have had only a pair of fields changing in intensity.

All the energy is stored up in the electric field at this point; something else must now happen, and it does so. The electric field can be thought of as a sort of

"stretched space" which is being stretched by the energy, and with no more push behind it, it begins to collapse.

This causes the voltage-change points to turn about and rush back down the elements toward the feed point. Since they are now going in the opposite direction, the accompanying magnetic field is reversed in polarity. When the voltage-change points each reach the feed point, the electric field is at minimum intensity. All of the energy which it contained has now been transferred to the accompanying magnetic field.

Remember that everything we've mentioned so far has been on the assumption that we simply changed the feed-point voltage suddenly from zero to a high value. If we hold this high value at the feedpoint, the voltage change points will go out to the end and bounce back as described, and this will continue several times until the ends of the wires have assumed a "steady-state" voltage. If you don't think DC can do such things, pull a spark from a 6-volt battery while listening to your receiver. You'll hear the "pop" of the waves that are generated by each spark, and it's this same process at work. You can get an even better demonstration from a mobile rig without noise suppression!

But if we feed this self-same antenna with RF voltage and adjust the antenna length so that each time the electric-field reference points reflect back to the feedpoint, they find a new "push" of just the right voltage and polarity awaiting them, then we have an oscillating pair of magnetic and electric fields around the antenna. In more conventional language, we have set up a "standing wave" on the antenna. During each cycle of RF, this standing wave launches an infinite number of travelling radio waves out into space.

Each tiny part of the antenna conductor acts like a separate antenna, and each radiates its travelling waves equally in all directions. In some directions, however, the travelling waves from the various parts of the antenna have phase relationships which cause them to cancel each other out, while in other directions the phase relationships cause them to strengthen each other. This gives rise to antenna directivity patterns—but that's part of a different article. What we're looking at right now is simply the means by which radio waves propagate.

Once launched into space, each "ray" of the radio wave cannot be forgotten. It still owes its existence to the crossed magnetic and electric fields, and its motion to their phase relationships. But if the ray encounters another conducting element—such as a receiving antenna or merely a piece of wire—which happens to be aligned in the same place as the ray's electric field, the voltage difference which is the characteristic feature of that electric field will be shorted out. And in the process, a current will flow in the conductor.

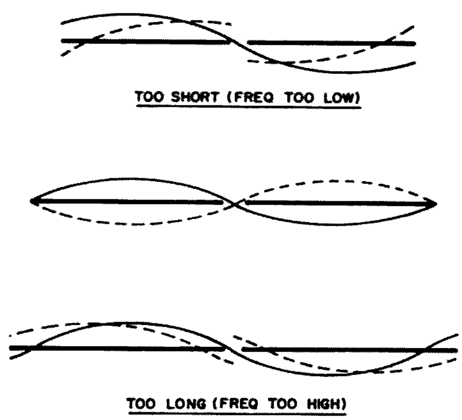


FIGURE 7. For most efficient propagation of radio wave, antenna's length must be matched to operating frequency. At top, antenna is too short (or frequency too low) and reflected electric field is out of phase with driving energy. Part of driving energy is cancelled. At bottom, antenna is too long (or frequency too high) and the same thing happens with opposite phasing. When antenna length is correct for frequency in use, center, reflected and driving fields are in proper phase and all energy goes outward.

The shorting out of the electric field and the resulting collapse of the accompanying magnetic field brings that particular ray to its end. However, the current flow in the conductor immediately gives birth to a new sphere of rays, each indistinguishable from the old except for the fact that the original total energy is split equally among all the new rays or waves.

Those new rays which happen to be going in the same direction as the original carry on its travel; some of the new ones, however, go off in new directions, and at least some head back for their original starting point.

If the conductor is a receiving antenna or other structure comparable in size to a wavelength, the same directional qualities already mentioned for transmitting antennas are present. However, since each individual ray is infinitesimally small (no matter how you spell it, that's mighty small; a single electron bears approximately the same size ratio to an infinitesimal as does the rest of the universe to that electron!) its electric field *can* get shorted out by some most minute particles—such as atoms which are temporarily deprived of one of their electrons.

The important point about the preceding four paragraphs, so far as the exam questions are concerned, is that the conductor must be aligned with the plane of the electric field of the wave. And the electric field, as we saw a few pages back, is what determines polarization.

Although it has nothing to do with the study questions we're examining this time, this also explains why vertical antennas and metallic masts interact with each other; the metallic mast shorts out part of the electric field from the radiated waves, and re-radiates in a somewhat unpredictable manner.

As we all know, the earth is a conductor of sorts. For this reason, horizontally polarized waves (those with their electric fields in the horizontal plane) interact with the earth more than do vertically polarized waves. This is one of many reasons why most broadcast stations (of the BCB variety) use vertical polarization. The interaction between earth and the horizontal waves tends to reflect the waves upward

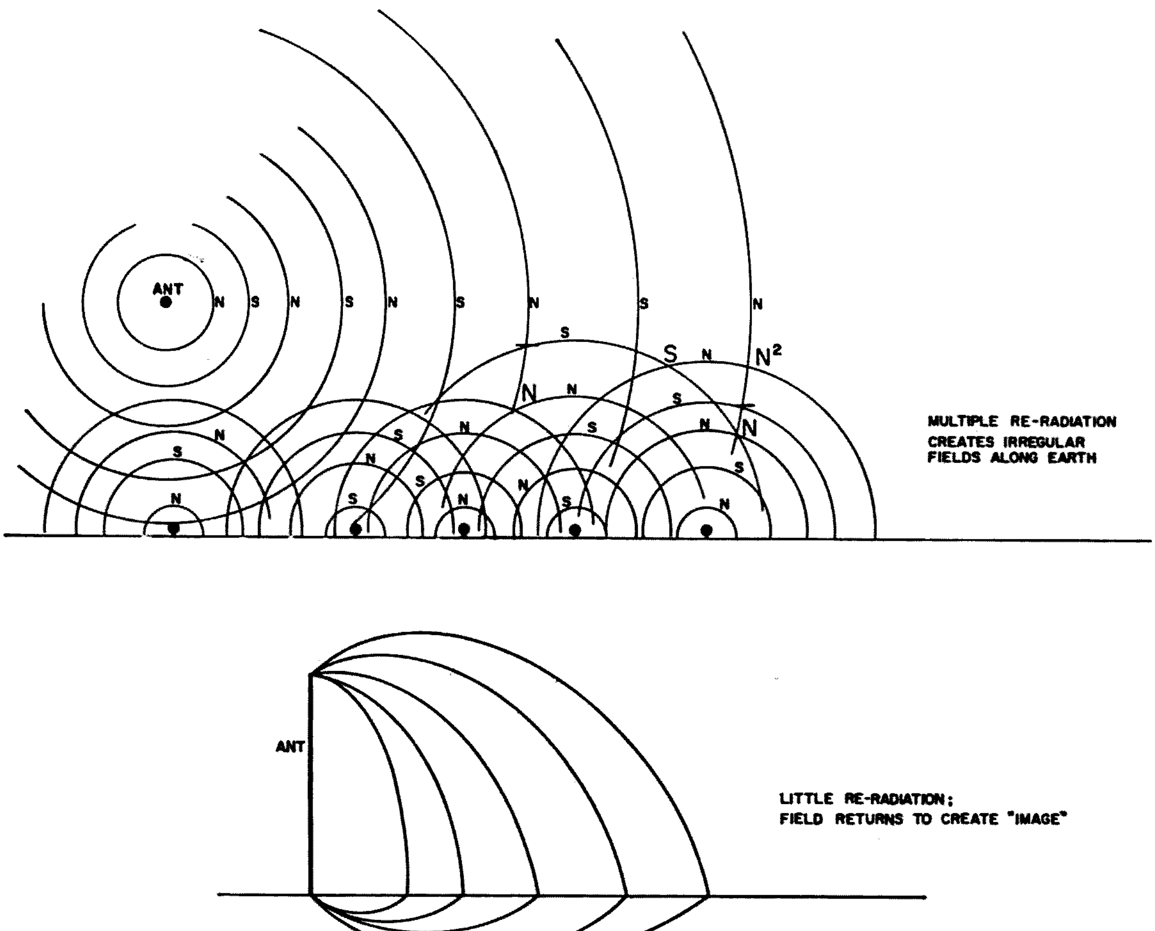


FIGURE 8. Horizontally polarized radio wave, top, interacts with the surface of the earth to produce irregular fields and also reflects, so that wave is unable to just skim the horizon. Vertically polarized wave, bottom, has less interaction with earth's surface and consequently provides better ground-wave coverage. Zero-angle radiation is also easier to achieve due to absence of multiple reflection.

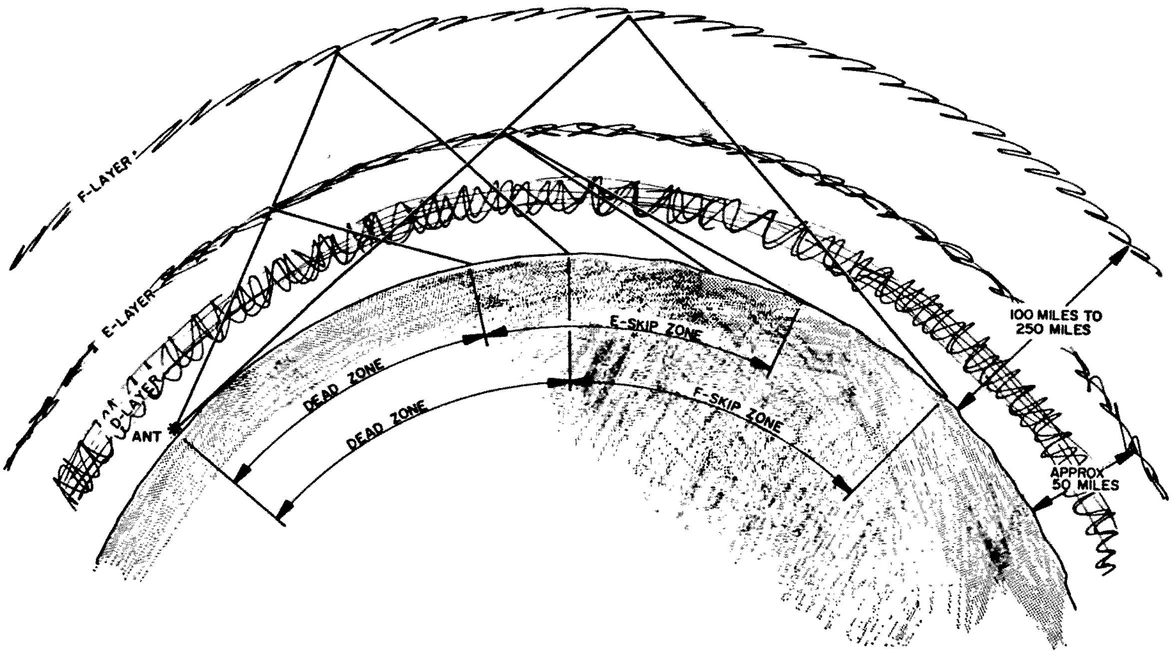


FIGURE 9. Ionized layers of atmosphere, or ionisphere, are shown here. D layer is strongest, and "shorts out" radio waves of low enough frequency to be affected by it. E layer, about 50 miles high, reflects waves which reach it. Maximum range of E-layer skip signal is about 1250 miles. F layers are highest and vary in altitude. Waves which reach them can attain ranges up to about 2500 miles; longer DX than this requires multiple reflection. However it is possible for wave to bounce from F layer and be reflected from E layer back to F, several times, and several instances of many-times-around-the-world signals with noticeable time delay have been observed.

at approximately line-of-sight distances; vertically polarized waves, on the other hand, suffer no such reflection. In fact, they even appear to "hug" the earth's surface, forming what is known to antenna engineers as a "ground wave". This is not at all the same as our normal usage of those words; the technical "ground wave" actually depends upon conduction through the earth for its electric-field return path. Waves which do not interact with either the earth surface or the ionized layers during their transit from transmitter to receiver are known as "space waves", while those which are bounced off the ionisphere are called "sky waves". Which brings us rather directly to the next question.

What Is The Ionisphere? The ionisphere has many names; the FCC study questions use the phrase "state of ionization of the atmosphere" and many persons know it as the "Kennelley-Heaviside layer". Most of us know it best by the alphabetical designations assigned to the various layers— D, E, F1 and F2. Before we go very far into what this thing is, let's pause and examine an ion itself.

An "ion" is simply a free atom of some chemical element which is temporarily missing an electron from its outer or "valence" shell. You can make a whole glassful of ions by dropping a teaspoonful of salt into a glass of water and stirring briskly. As the salt (sodium chloride) dissolves, its molecules split into ions of sodium and chlorine. These, in turn, ionize the water itself into hydrogen ions and "hydroxyl" ions composed of a single atom each of hydrogen and water.

If you now drop a pair of wires into the glass and apply some direct current, you can measure current flow through the ionized solution.

If, on the other hand, you clean out the glass quite thoroughly, then fill it with distilled water and again drop in the wires, you may be surprised to discover that water by itself is a fairly good insulator!

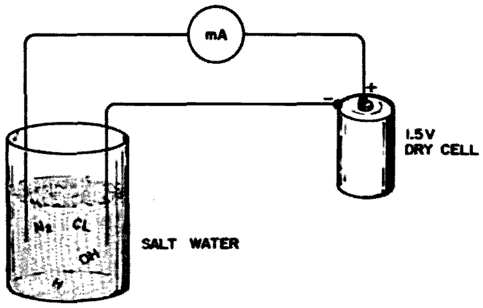


FIGURE 10. You can prove that "ions" are electrical conductors with this experiment. If the glass contains absolutely pure (distilled) water, little or no current will flow. Addition of some salt permits the water to ionize into sodium (Na), chlorine (Cl), hydrogen (H), and hydroxyl (Oh) ions, and current then flows freely.

What makes moisture so conductive is simply the fact that almost anything dissolved in water results in ionization of the water, and ions are excellent conductors.

Now for the ionisphere. The earth, of course, is surrounded by a layer of air known as the atmosphere. If you want to be strict about it, you can say that the atmosphere extends at least halfway to the moon, and for an equal distance in all other directions—but well over 99 percent of it is in a layer approximately 50 miles thick around the surface of the planet.

In that never-never land more than 50 miles straight up, radiant energy from sunlight, cosmic rays, and many other sources is able to knock electrons free from any atoms it may happen to hit, and atoms are so scarce up there (it's a better vacuum than you'll find in any tube) that it may take days for a wandering electron to come along and de-ionize the resulting ion.

As a result, the top surface of the atmospheric layer is in a relatively constant state of ionization. On that part facing the sun—the part above the daylight regions—the high energy of the sun's rays produces ionization at an altitude which is fairly low. This ionization is also rather intense. It is known as the "D" layer, and because of its intensity (and many other factors) acts as an efficient absorber of radio energy.

When the sun's light moves away, to other parts of the planet, the ions at lower altitudes (where there are more atoms and free electrons available) recombine into non-conducting atoms and the D layer disappears. The recombination process may take all night, especially if the original layer was quite intense, but a definite day-to-night variation is obvious.

At the higher altitudes, where less material is available for recombination, the ionization persists around the clock. It appears to be concentrated in two layers, known as the "E" and "F" layers, and the F layer additionally appears to move up and down with the clock, giving rise to the "F1" and "F2" names. This is probably due to the different kinds of gas atoms present at different altitudes, and to a smaller degree to the amount of energy received from the sun and other sources such as micrometeorites.

Since ions *are* good electrical conductors, they affect radio waves in the same manner as any other conductors. And since the ionized layers appear to cover the planet in the same manner as the more familiar atmosphere, they form conductors which are always large in comparison with wavelength. With these two hints, let's dive a little deeper and see specifically how the layers affect radio waves.

How Does The Ionisphere Affect Propagation? Several pages back, while examining how radio waves are propagated, we found that a large conductor in the same plane as the wave's electric field would

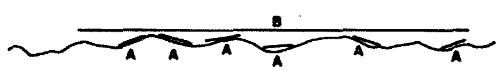


FIGURE 11. "Smoothness" of any surface depends upon the size of the measuring stick as shown here. With a short measure, A, this surface tilts in various directions and so is considered "rough"; with a long measure, B, it is level and so "smooth". This effect is what makes the ionosphere's action frequency-dependent, since the measuring stick is the length of the radio wave. For short waves, the surface is rough and "scatters" the wave; for longer waves, the same surface is smooth and so reflects them.

cause the original wave to be converted into a new sphere of wavefronts, going in all directions, by shorting out the electric field.

At that time, we didn't go into the effect very deeply. Getting a clear grasp of just how it works isn't the easiest thing in the world, because any real radio wave (as opposed to the theoretical single rays we've been looking at so far) consists of an infinite number of rays which fan out through both space and time—and the interaction between this *wavefront* and a conductor then depends not only upon the shorting of the electric field, but also upon the direction from which the wavefront approaches the conductor, the frequency of the wave, the excellence of the conductor, and a few more factors even more exotic.

For a first glance, think about what happens when light hits any surface. Unless the surface happens to be an absolutely dead matte black, some of the light is reflected off of it. A little of the reflected light goes back toward the source, but most goes in other directions. If the surface is smooth enough, at certain angles almost all of the light is *reflected* in a new direction and almost none is *scattered* in any other direction.

The major difference between light and radio waves is the frequency and/or wavelength involved; both are electromagnetic radiation. The materials we know as electrical conductors don't have exactly the right atomic characteristics to "short out" light—but virtually all conductors are opaque, so you might say that they actually do "short out" the light energy which would otherwise go right through them. And similarly, almost all good insulators are transparent. If you raise the objection that ionized water is a good conductor yet is transparent, consider that it is *less* transparent than is distilled water, and also is *not* as good a conductor as a copper or silver bar.

The ionized layers at the upper edge of the atmosphere are conductors, and frequently have surfaces which are smooth in comparison to the wavelengths involved (that's how "frequency" gets into the act—a surface is considered "smooth" if its irregularities are small in comparison with the wavelengths involved, and wavelength varies with frequency). Under these conditions, radio waves striking these surfaces at the proper angles are reflected, just as are light waves striking a glossy surface.

Since the radio waves are of much lower frequency than are light waves, the reflection process isn't as abrupt as that for light. The wave actually appears to turn, in a gentle curve; light waves do so too, but the curve's radius is related to wavelength in such a manner that the curve is undetectably small for light waves, but readily measured when radio is involved.

The major factor which determines whether a wave is *reflected* in predominantly one direction or *scattered* in all directions is the smoothness of the surface. Keep firmly in mind that at any one instant in any one spot above the atmosphere, the actual surface of the ionized layer is constant. Its actual "smoothness" or "roughness", as you might measure with a yardstick or straightedge could you go up there to see, would remain the same.

But for the radio waves, the "smoothness" is measured not by a yardstick or straightedge, but by comparison to the wavelength; and wavelength is tied directly to frequency.

For instance, if the surface had hills and valleys which ranged from 3 meters deep to 4 meters high, and were spread out in a roughly dimpled pattern with an average of 10 meters between adjacent hills or valleys, then for a 10-meter wave approaching the surface the going would be rough. The peak-to-valley distance would be 7 meters, or 70% of the wavelength, and the peak-to-peak distance would be 10 meters, or 100%.

However, a 160-meter wave approaching that same surface would find it comparatively smooth; peak to valley distance would be only 7/160 or about 4% of the wavelength, and peak-to-peak distance would be 10/160 or a little over 6%.

This is the reason that the effect of the ionisphere on propagation is frequency-dependent. A smooth surface is required for reflection, and the smoothness depends upon the frequency involved.

For the same conditions in the ionisphere, reflection is always strongest for the lowest-frequency waves. As frequency rises and wavelength decreases, the effective smoothness of the surface becomes less and reflection becomes less and less effective. As

frequency continues to rise, the wavelength eventually becomes short enough that the waves appear to pass right on through, like light going through glass.

This happens first when the waves are going straight up and so meet the ionized layers "head on"; when the waves hit an an angle, they may still reflect. However, even when the waves strike the ionized layers at the sharpest possible angle (leaving the transmitter and just skimming the horizon), you'll eventually reach a frequency at which reflection ceases. The highest frequency at which reflection still occurs is known as the "maximum usable frequency" or "M.U.F.", and will naturally vary from minute to minute and hour to hour as the state of the ionized layers changes. For maximum range in DX seeking, it's best to work as near as you can to the MUF, but never right on it (even if it's in the middle of a ham band) since you are then subject to rapid and unpredictable fading.

The frequency at which reflection from straight overhead ceases, incidentally, is called the "critical frequency" and is used by propagation researchers to determine the MUF. Each of the ionized layers has its own MUF and critical frequency; the E-layer MUF is about 5 times the critical frequency while the MUF for the F2 layer is about 3 times the critical frequency. These MUF's are for maximum possible range, of some 2500 miles for F2 and 1250 miles for E-layer. Any paths over greater ranges involve multiple hops, with two or more skips from ionisphere to earth and back between transmitter and receiver.

About three paragraphs back we noted that reflection is always strongest at lower frequencies; however, signals are usually better right at the MUF. This apparent contradiction is due to the D layer of ionization which normally is present only during daylight hours. This layer is so intensely ionized that it is almost completely opaque to the lower frequencies; only the higher frequencies can survive it to reach the effective upper layers. Both the 160 and 80-meter bands are wiped out during daylight for ranges beyond 100 miles or so by this effect. The 40, 20, 15, and 10 meter bands are not so greatly affected. VHF does not suffer at all. Therefore if you want medium-range contacts during daylight, your primary choice would be between 40 meters (where the critical frequency might permit a straight-up straight-down reflection with consequent good coverage) and a VHF band such as 50 or 144 Mc (where medium-power and scatter techniques can give consistent 400-mile range). For daytime DX, the highest usable one of the 20, 15, and 10 meter bands would be preferable, since MUF normally drops in the early evening, nighttime DX is usually best on 40, 20, and 15.

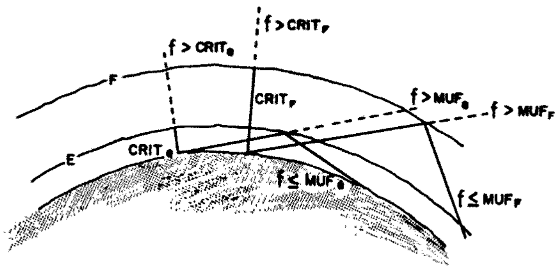


FIGURE 12. Critical and Maximum Usable frequencies for both E and F layers are shown here. When operating frequency (f) is above MUF for layer and path, signal goes on into outer space without returning to earth. Each layer and each path has its own MUF, which varies from minute to minute. MUF predictions are made by measuring the Critical frequency, at which straight-back reflection occurs.

The daytime-nighttime relationship isn't the only way in which the sun affects the ionisphere. Let's continue to the last of our questions and look at some other implications.

How Does The Sun Affect The Ionisphere? We've already looked at the means by which the radiant energy from the sun ionizes the gases of the upper atmosphere to form the ionized layers or ionisphere, in terms of the 24-hour day-night cycle of Earth's rotation. This is not, however, the only effect of the sun.

While science does not yet know all the reasons why—or even all the details necessary to put its questions accurately—it does know that the sun has a "sunspot cycle" of approximately 11 years duration. During this 11-year cycle (we're just winding up for the peak of the 19th such cycle studied), the count of freckles visible on old Sol varies from a minimum to a maximum number. The last cycle set all-time records, three years running, for high sunspot counts and accompanying solar activity. In addition to the spots, the sun appears to undergo severe magnetic disturbances, and to spray out

streams of charged particles with extreme energy.

These "magnetic storms" and "solar flares" occur predominantly during periods of high sunspot count; such periods appear to be relatively active ones for our nearest star, and the minimum-sunspots part of the cycle appears to be the quiet time.

When the sun is active, the solar flares, magnetic storms, and less spectactular but still energetic goings-on result in additional energy reaching earth, and a consequent increase in the ionization of the ionisphere. This in turn shows up as dramatic increases in MUF for any given point-to-point radio path; during the 1957-58 peaks a number of VHF men worked all continents on 50 Mc by means of F2 skip, which normally never gets much above 30 Mc. The increase in ionization also hurts by making the D layer stronger and keeping it alive longer at night, so that 160 meters is almost unusable at any time during the strongest peaks of the cycle.

The changes in the D, E, and F layers brought about by the sun's changes of activity then modify the frequency recommendations mentioned in the previous question. Those recommendations are based upon "average" conditions which almost never exist. When the sun is most active, move all conditions one band higher. When the sun is most quiet, move one band lower in frequency (from 40 to 80, etc.) While this isn't precisely the most accurate way to do it, the limitations of amateur band assignments prevent any more accuracy anyway.

The sunspot cycle isn't the only thing which changes. As our planet moves from winter to summer, the angle at which the sun's energy hits the ionisphere above us also changes—and this, too, changes the energy reaching the layers. The MUF moves up in the summertime, and down in the winter, to almost as great a degree as it does during the 11-year sunspot cycle. To sum up, then, the ionization is most intense, the MUF and critical frequencies highest, and the D-layer losses worst for lower frequencies, on a hot summer day around noon to early afternoon local time during the peak of the sunspot cycle. Conversely, the ionization is weakest, the MUF and critical frequencies lowest, and the D-layer losses least, between midnight and 5 a.m. local time on cold winter nights during the minimum of the sunspot cycle.

When ionization is highest, it's possible to work someone halfway around the world on 50 Mc by double-F-skip propagation (and a few other E skips as well). When ionization is lowest, you can get almost as great distance on 160 meters. In between, you can pick your frequency and power to suit the distance and specific directions in which you want to work, according to the state of the ionisphere at that time (as determined by listening to the various bands and finding out who's coming in, from where, at what frequencies), and take part in one of the most gigantic games of chance ever started!

Next month. Much of the scope of the new examinations appears to cover single-sideband principles and techniques. In the next instalment, we'll go into them in the same amount of detail. Until then, good DX.

Next: Questions 3, 7, 8, 25, and 44 of the FCC list, all dealing with SSB. ■

The Omega DA Keyer

With the advent of incentive licensing, lots of our long time phone operators are coming to the realization that CW is a necessary evil. It is more than coincidence that the 75 meter round tables seem to drop in numbers when the W1AM code broadcasts are scheduled to begin. For some, the return to CW is a temporary thing and simply a means to the end of achieving the higher class license. For others, it is a discovery that CW can be fun after all. For the straight key man or the "bug" artist, the discovery of automatic keying can mean the difference between fun and a chore. Once mastered, the Omega DA keyer provides the maximum in fun.

The DA keyer is a fully automatic solid-state device using integrated circuits, transistors, and diodes where each will perform the job best. It requires no external connections except to the transmitter key terminals. It can be operated from a variety of power sources, but the DA-3 optional power supply will provide the most reliable source and should be considered, especially by the CW operator who will be using the keyer regularly. This option permits the operator to borrow 6.3 volts from the receiver or a small filament transformer. Internal batteries or an external DC power source can be used with good success.

The keying is also versatile. The DA can be used with a straight key for non-automatic sending, or with any type paddle you prefer. For perfect CW the use with a squeeze type paddle is the best method. The instruction manual which accompanies the device gives full instructions for learning the squeeze method of sending. This requires a few hours of practice but the end result is perfect code every time.

Squeezing the two paddles together produces alternate dashes and dots. To produce the letter C, you squeeze the two paddles with a slight advance to the dash paddle and the letter is automatically formed. Insertion of either a dash or dot is easily accomplished. To form a letter F, merely squeeze the dot side and insert the dash at the appropriate time. This may sound terribly complicated on paper, but in practise it is a matter of playing with the DA keyer for a short time until you have mastered the technique. If you are accomplished with either a bug or another type of keyer, the transition is an easy one and you can simply

continue your present system of motion, but some characters are so much easier to send using the squeeze method that the time required to learn the new technique is well worth the effort.

The DA has a built in monitor which is extremely pleasant to listen to as it is not a perfect sine wave output. This should reduce fatigue for the contest operator who has to listen to the monitor for hours on end. Volume and tone are completely adjustable.

The DA keyer is adjustable from 6 to 60 words per minute and should satisfy all the requirements of any CW operator. The gap and tension adjustments are internal, but are easily made, and, once the proper adjustment is made, it remains stable.

I began with a hand key, graduated to a bug, and have used a variety of automatic keyers from home brew to the more sophisticated commercial ones. The DA is a dream. The only problem is with automatic perfect keying, the characteristic "first" is disappearing from the CW bands. Time was when one could tune across a CW band and recognize a CW signal like one can identify a voice. These days, we all have the same voice on CW and I have to listen to the calls to find old friends. However, once I find them, copy is much easier.

Specifications:

Speed range: 6-60 Words per minute.
Output: Reed Relay, 250V, 3A, 50 watt maximum ratings. Power Requirements: Internal Batteries (.30 Watts or 10-14 VDC @), 100 mA (intermittent), or 6.3 VAC @ ¼ A (requires DA-3 option).

$85.00 Wired and Tested. Omega Electronics Co. 10463 Roselle St., San Diego, Calif. 92121

Propagation Chart

MARCH 1968

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	14	7	7	7	7	7	14	14	21	21
ARGENTINA	21	14	14	14	7A	7	14A	21A	21A	21A	28	21A
AUSTRALIA	21A	21	14	7B	7B	7B	7B	14A	14	14	21A	21A
CANAL ZONE	14	14	14	7A	7	7	14A	21A	28	28	28	21A
ENGLAND	7A	7	7	7	7	14	21	21A	21A	21A	21	14
HAWAII	21A	14A	14	7B	7	7	7	7B	14A	21A	21A	21A
INDIA	7A	7A	7B	7B	7B	7B	14	21	21	14	14	14
JAPAN	21	14	14	7B	7B	7B	7	14B	14B	14B	14	21
MEXICO	14	14	14	7	7	7	14	21	21A	21A	21A	21A
PHILIPPINES	14	14	14	7B	7B	7B	7B	14	14	14B	14B	21
PUERTO RICO	14	14	14	7A	7	7	14	21	21A	21A	21A	21
SOUTH AFRICA	14	14	7	7B	7B	14	21A	21A	28	28	28	21
U. S. S. R.	7	7	7	7	7	7B	14	21	21	14	14	7B
WEST COAST	21A	14A	14	7A	7A	7	7	14	21	21	21A	21A

CENTRAL UNITED STATES TO:

ALASKA	21	21	14	7	7	7	7	7	14	14	21	21
ARGENTINA	21	21	14	14	7A	7	14A	21A	21A	21A	21A	28
AUSTRALIA	28	21	14	14	14	7	7	14	14	14	21A	28
CANAL ZONE	21A	14A	14	14	7A	7	14	21	28	28	28	28
ENGLAND	7A	7B	7	7	7	7B	14	21	21	21A	14	14
HAWAII	28	21	14	14	7A	7A	7	7B	14A	21A	21A	28
INDIA	14	14	14	7B	7B	7B	7B	14	14A	14	14	14
JAPAN	21	14	14	7B	7B	7B	7	14B	14B	14B	14	21
MEXICO	21	14	7	7	7	7	7	14	21	21	21	21
PHILIPPINES	21	14	14	7B	7B	7B	7B	7B	14	14B	14B	21
PUERTO RICO	21	14	14	14	7	7	14	21	21A	21A	21A	21A
SOUTH AFRICA	21	14	14	7B	7B	7B	14A	21A	26	28	26	21
U. S. S. R.	7B	7	7	7	7	7B	14	14A	21	14	14	7B

WESTERN UNITED STATES TO:

ALASKA	21A	21	21	14	7	7	7	7	14	21	21	21A
ARGENTINA	21A	21A	21	14	14	14	7	14A	21A	21A	28	28
AUSTRALIA	28	28	21A	21	14A	14	7A	7	14	14	14A	28
CANAL ZONE	21A	21	14	14	14	7	7	14A	21A	21A	28	28
ENGLAND	7A	7B	7	7	7	7	7B	14	14A	21	14A	14
HAWAII	28	28	21A	14	14	14	7A	7	14A	21A	28	28
INDIA	14	21	14	14	7B	7B	7B	7B	14	14	14	14
JAPAN	21A	21A	21	14	7B	7B	7	7	7A	14	14	21A
MEXICO	21	14	14	7	7	7	7	14	21	21	21	21
PHILIPPINES	28	21A	21	14	14	14B	7B	7B	14	14	14	21
PUERTO RICO	21A	14A	14	14	14	7	7	14A	21A	28	28	28
SOUTH AFRICA	14	14	7	7B	7B	7B	7B	14	21A	21A	21A	21A
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14	14	14	7B
EAST COAST	21A	14A	14	7A	7A	7	7	14	21	21	21A	21A

A. Next higher frequency may be useful at this hour.

B. Very difficult circuit this hour.

Good: 1, 3-7, 14-16, 18-21, 23-24, 26, 27, 30, 31.
Fair 2, 8-13, 17, 22, 25, 28.
Poor: 29.
VHF: 14, 15, 16.

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GOING SSB—DX60, matching HG-10 VFO. S-118 rcvr, enclosed speaker, antenna relay, all cables, crystal. LOT $150. WA9SXE, 208 S. 8th St., Goshen, Ind. 46526.

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CARDWELL PL-8013 VARIABLE CAPACITORS, 50 to 1500PF, 0.030″ spacing. Ideal for that linear. Brand new, $27.50 postpaid. Supply limited. Slep Electronics Company, Drawer 178P, Ellenton, Florida 33532.

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WRL's used gear has trial-guarantee-terms. Thor 6-ac/ps—$169.95; G76—$99.95; HW12—$94.95; 650A—vfo—$99.95; Apache—$119.95; Ranger II—$169.95; HX20—$149.95; HA10—$189.95; SX99—$89.95; SX122—$199.95; 75S1—$299.96; HQ170AC—$239.95; 2B—$179.95; NC270—$139.95; Hundreds more. Free "blue book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

FOR SALE. Tektronix 180S-1 time mark generators, 105 square wave generators, 514AD oscilloscope, H-P 524B counters and other equipment. Wanted: Collins 30S1. Write Box 381, 73 Magazine, Peterborough, N.H. 03458.

NCX-3 TRANSCEIVER with xcu-27 calibrator and NCX-A power supply, all in good condition. $290. Philip Hunrath, 47 Parker Pl., Shrewsbury, N.J. 07701.

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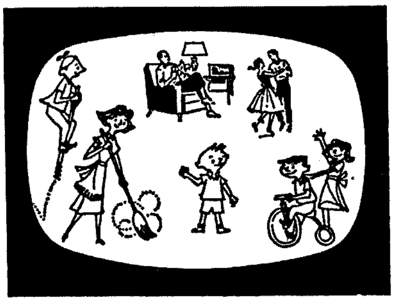

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GO SSB: HT-32, $230; late HQ-170c, $175; Zeus, $320; all excellent condition; I want either SB-101 or TR-(3 or 4) or ?; WA9PUR, Route 2 Box 141, Cedarburg, Wisc.

TEENAGERS! If you are a teenager, we want you for 15M SSB traffic and rag chew net now being organized. Write WA5PIE, Rick Rumbaugh, 124 Washington, Tucumcari, New Mex. 88401.

DRAKE 2B, 2BQ, 2AC, $195. Heath HW30 $35. Globe HG-303 transmitter $25. All excellent condx. Harvey Arnold, 67-42 224 St., Bayside, L.I., N.Y. 11364.

ATTENTION HOMEBREWERS: V.H.F. toroid cores, very high "Q" on 6 and 2 meters. Write FREE technical information, prices, schematics. HALCO, Box 283, Saxonville, Massachusetts 01706.

SX-111, $125. SX-140, $50. Globe Scout 680-A, $35. College is coming. Willing to haggle prices. WAØRAO, Mark Lund, RFD 1, Jewell, Iowa 50130.

HF-VHF-UHF Communication and instrumentation products for amateurs. Catalog 25¢ refundable with first order. Mailing list. Radiation Devices Company, Box 8450, Baltimore, Md. 21234.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

MOTOROLA new miniature seven tube 455 kc if amplified discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

TOROIDS—DIODES—COAX—CONNECTORS. 88 mH toroids—45¢ each, 5/$2.00. 1000 PIV 1 Amp Top-Hat Diodes—55¢ ea. 2/$1.00. Connectors, PL259, SO-239, M359—45¢ ea. 10/$4.00. Button feedthroughs (while they last) 500 pF @ 500 V. 20/$1.00. Add sufficient postage. R and R ELECTRONICS, 1953 S. Yellowstone St., Springfield, Ohio.

VARIACS—General Radio and Ohmite, 60 cycles Input 120V—output 0-280 V. 1 amp or input 240 V—output 0-280 V. 2 amp. PULLOUTS IN GUARANTEED EXCELLENT CONDITION $6.95 plus postage. Shipping weight 10 lb. R & R ELECTRONICS, 1953 S. Yellowspring St., Springfield, Ohio.

WANTED: Military, commercial, surplus, Airborne, ground, transmitters, receivers, testsets, accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

TELETYPE TEST SET I-193C. Brand new surplus. Tests RTTY transmitters, converters, relays, $24.95. F.O.B. Harrisburg, Pa. Telemethods International, P.O. Box 18161, Cleveland, Ohio 44118.

IDEAL COMPANION FOR HT-44 Hallicrafters SX117, receiver. Needs slight repair. $225 or best offer. Bob Martin WB2WBA, Box 36, Katonah, New York 10536.

ROCHESTER, N.Y. headquarters again for the big Western New York Hamfest and VHF Conference Saturday, May 11.

DUMMY LOAD 50 ohms, flat 80 through 2 meters, coax connector, power to 1 kw. Kit, $7.95, wired $11.95, pp Ham KITS, Box 175, Cranford, N.J.

BECKMAN COUNTERS. Transistor 6147 50mc (will cover 6 M) $1000. #7370 tube 10.5 mc $600. No shipping. Swap for Swan 500, Galaxy V, linear. WA6TFP.

HEATH HR-10 rcvr $50, HO-13 ham scan $45, Ameco TX-62 with relay $100, National 6&2 vfo $30. Wayne Schenk, 3385 Randolph Place, Hobart, Indiana 46342.

FOR SALE: HT-40 and S-108 with Heath GD-125 Q-Multiplier, Johnson 114-100-3 key, low-pass filter and ant relay $180. WA2ADU, 130 Helen St., Binghamton, N.Y.

MECHANICAL ELECTRONIC DEVICES CATALOG 10¢ . . . Teletype Model 14 reperforator with automatic tape take up rewinder 115VAC60cy. Both units new, unused $69.95 . . . ARR27 Receiver 29 tubes 465-510 MHz w/60 MHz if new, unused $35 . . . 1/16 laminated copper clad 2 oz. 2 sides, for printed circuits 9½x4½ $1 . . . 3/$2. Transistor boards bonzana $5.95 . . . Wide band balanced modulator $4.95 . . . 30 MHz IF Assembly $5.95 . . . Transmitter TDG w/Modulator easily converted to 2 meters $49.95 . . . Low pass filter 0-32 MHz 52 ohm $9.95 . . . 5KV/2KV/1KV at 750 ma/200ma/250ma Power supply write for details. Fertik's, 5249 "D", Phila., Pa. 19120.

THE NORTH JERSEY DX ASSOCIATION is sponsoring its annual DX Round-Up on Saturday, March 23, 1968. This is the Saturday following the IEEE Convention in New York and it is expected that many out-of-towners will find it convenient to attend. Site of the Round-Up is the Holiday Inn, Wayne, N.J. at the intersection of Route 46 and Route 23, just 30 minutes west of the George Washington Bridge. The afternoon program starts at 2 P.M. and banquet at 7 P.M. Further details available from W2PXR.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB P. Wandelt, RD # 1, Unadilla, New York 13849.

NATIONAL NC303, 6 meter converter, XCU-27 calibrator, mint condition, $275. Utica 650 Six meter transceiver, VFO, mike, $130. Richard Ravich, 10 Coolidge Road, Marblehead, Mass. 01945.

DAYTON HAMVENTION April 27, 1968—Wampler Arena Center, Dayton, Ohio, sponsored by Dayton Amateur Radio Association. QSO in person at the nations foremost radio event of the year. Technical sessions, exhibits, hidden transmitter hunt. Bring the XYL for an outstanding Ladies program. Join the satisfied participants who return year after year. Watch the Ham ads for information or write Dayton Hamvention, Box 44, Dayton, Ohio 45401.

COMPLETE 6 & 2 Meters featuring Heath Seneca transmitter & National NC-140 receiver, Ameco converter & pre-amp. $300. K8YVG, 6140 Niles, Troy, Mich. 48084.

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500 WATTS AM & CW. Johnson Ranger $125, Courrier amplifier $150. Package deal $250 or your best offer. Charles Trautmann, Deerfield Academy, Deerfield, Mass. 01342.

73

/ 88

APRIL 1968

60¢ (No Foolin')

AMATEUR RADIO

UFO

April 1968
Vol. XLVII No. 4

73 MAGAZINE

Peterborough, New Hampshire 03458

Cover: UFO Photo courtesy of National Investigations Committee on Aerial Phenomena

Kayla Bloom W1EMV
Editor

Wayne Green W2NSD/1
Publisher

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $12.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

I have avoided the subject of incentive licensing, partly because I was too cowardly to rock the boat, but mainly to give myself time to sort out my own thinking on the subject.

Being firmly convinced that some portion of each person's day (ham radio or not) should be devoted to a learning process, I can find little to argue in the final act as it was passed. It will certainly do us no harm to increase our technical ability. I seriously doubt that it will have any major effect on operating tactics or improvement of the conditions of the bands as they now exist, however. For example, one does not have to be an automobile mechanic to be an excellent driver. Nor does FAA require that a pilot be an airplane mechanic before he can be qualified to fly. I know many "appliance operators" who are superb amateur operators, and many skilled electronic engineers who cannot zero a frequency adequately, although they can keep their own and other's rigs in good running condition. What the long term effect on operating techniques will be remains to be seen.

To me, and I'm sure to most of us, the term incentive means working harder to achieve more privileges. This is like the man who is hired for a job at $150 per week and has the opportunity to work harder to make $200 per week. He has the option of staying where he is and keeping his $150 if he so desires. However, with incentive licensing as it now exists, we have the situation of the man who has been making $200 per week for many years suddenly being cut to $150 per week and now has the "incentive?" to work harder to get back to the previous status.

Then, let's look at the "grandfather clause" for the Advanced class holders. In 1965, in a proposed amendment to Amateur Radio Service Rules (March 31, 1966), the FCC officially stated, *"There no longer exists any valid distinction between the Advanced and General Class as to the difficulty of the examination."* However, the holder of the Advanced Class license now gets additional frequencies under the new regulations, although he may not have taken an examination in 40 years. There is always the argument that these people have learned theory through practice in building and maintaining equipment throughout the years. While this may be true, in many cases, it cannot hold for all the old timers any more than saying that none of the General Class holders has done any building simply because commercial equipment has been available to them.

But let us defer to age, and accept this gesture. There still remains, within the Advanced grandfathering, one inequity. Let's cite two hypothetical amateurs. Ham "A" was licensed 40 years ago with what was then called a standard Amateur Radio Station License. A few years later he took a new exam and received what was called an Amateur Extra First Class License. Came the thirties with the depression, and for financial reasons he was unable to indulge in the luxury of a hobby. He was too busy scrounging a living for his family to be on the air. Knowing he would be inactive, he let his license lapse. For a variety of reasons, he was unable to return to amateur radio until 1953. At that time there was no longer any Advanced Class license, so he took the General exam and returned to the air.

Meantime, ham "B" was licensed at the same time and took the same original two exams. He was also inactive for the same period of time, but kept renewing his license throughout the years. Although "B" has not taken any exam since 1928, he holds the Advanced license with all the additional privileges, while "A", who has taken an additional modern examination which, by the FCC's own admission, eliminates any difference between the two classes, has a General.

I would like to suggest that the FCC give serious consideration to allowing one who once held an Advanced Class license which expired, and who has taken the General exam in recent years, to be granted the Advanced license with all the benefits which go along with it. . . . W1EMV

de W2NSD

never say die

Can Amateur Radio Help Solve the UFO Problem?

If the UFO's are, as many believe, space craft visiting our planet, can you think of a more important event of our times? Fortunately for us the problems facing UFO investigators can be solved by amateur radio. One single amateur, providing leadership at this time, might do more for the human race than a president or king.

A number of good UFO books have been published recently and those of you who have digested them probably feel about as I do. The mere fact of thousands of identical reports from all over the world by people who could not possibly have cooked up these things previously indicates the truth of the reports. The credibility gap being what it is these days, the poo-pooing of UFO's by our government is also a strong endorsement of their existance. Something is there and we should be doing everything in our power to find out more about it.

Those of you who are familiar with the developing story of the UFO's realize that so far the government investigations of sightings have always been for the purpose of proving them non-existant. So far there has not been one single government attempt to scientifically investigate the UFO phenomenon. If instead of sending out an occasional investigator to talk with someone who has reported a sighting they would organize a team or two of scientists and rush them to the area of a sighting with the idea of taking pictures of the UFO's while they are still there and checking for radiation, magnetic variations, electrostatic fields, etc., we might start to learn something about them.

The obvious problem here is to set up a network which will enable scientific teams to know immediately where a UFO has been spotted and where it is heading. Frankly I can't think of anything other than amateur radio that could fill the bill. You need something that is ubiquitous, reaching into every community. Telephones do this, but imagine the cost and complexity of trying to set up a national network of phones for instant communications! Thousands of amateurs can all listen on one frequency and hear any

(*Turn to page* 84)

R. O. Gibson W8TYY
7700 Cubbage Rd.
Westerville, Ohio 43081

The Vidicon Minicamera

The availability of low-cost high-quality semi-conductors has permitted the design and construction of a small, efficient, stable CCTV vidicon type camera at moderate cost.

The camera to be described has been used primarily for ATV, however, many other uses suggest themselves. Since this camera requires only 12 volts, it can be used in mobile or remote work where no 115 V 60 Hz power is available. This unit features field effect transistor input for low-noise video, unijunction sweep oscillators for reliability and simplicity, sync inputs, 6 MHz band-width, built-in mechanical focus, and low input power requirements. The total power input is only 3 watts!

To aid in construction and operation of the camera, and to get an idea what makes it work, we will delve lightly into the circuit operation within the camera.

Circuit Description

Video amplifiers

The vidicon target current fluctuations, which comprise the video signal, are impressed across R 1, which serves as the vidicon load. Since the gate circuit of Q 1 is a very high impedance network, the gate receives a relatively high voltage signal (approximately 200 mV). Q 1 is connected as a source follower, which provides low impedance drive for the base of Q 2.

Due to the stray capacitance associated with the target of V 1 and input to Q 1, the video response will start to fall off around 15 KHz and continue to drop at an rc rate (6 dB/octave). Q 2 has a frequency response which is complimentary to the input response, thereby giving flat over-all video response. This is accomplished by controlled emitter degeneration at low frequencies. C 3 sets the breakpoint of the peaking stage (Q 2).

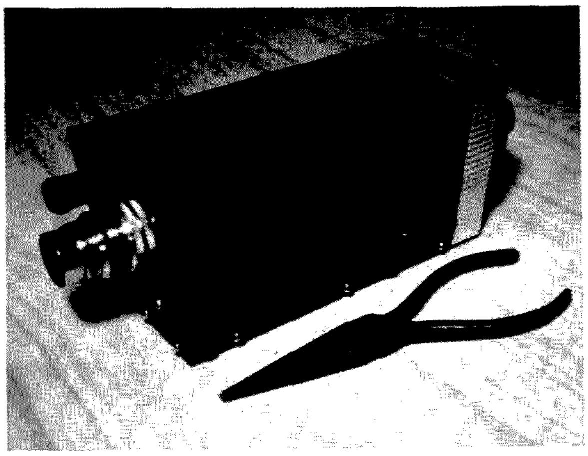
Q 3 is an emitter follower, which prevents the output stages from loading the peaking stage. R 6 adjusts overall video gain. Q 4 is the keyed clamp. When Q 4 receives a pulse from the vidicon blanking circuit, Q 4 conducts, clamping the input of Q 5 to a level determined primarily by the setting of R 27. R 27 therefore controls the blanking level.

Q 5, Q 6, and Q 7 comprise an output feedback amplifier with a gain of approximately 35 and low output impedance to drive the 75 ohm video line.

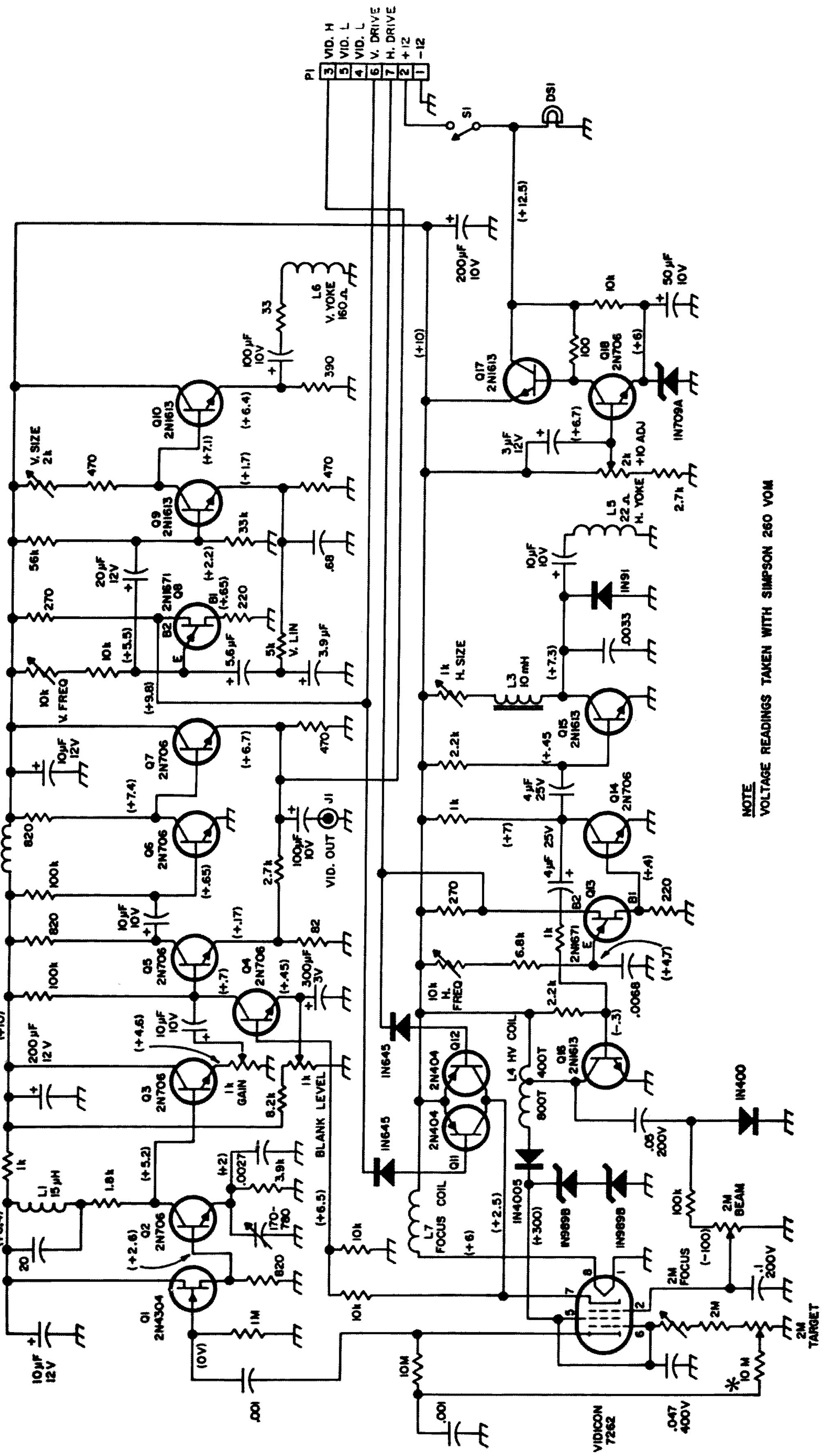
Vertical deflection

The vertical sweep system utilizes a unijunction transistor Q 8, as the frequency generator. This type of device is very useful as a relaxation oscillator due to the fact that when the emitter voltage rises to a fixed percentage of the voltage between the two bases, the unit will suddenly conduct. All that is necessary to construct a relaxation oscillator is to provide an rc charging circuit for the emitter. In our camera, this circuit consists of R 14, R 15, C11 and C 12.

C 11 and C 12 charge toward the supply



The completed camera



NOTE
VOLTAGE READINGS TAKEN WITH SIMPSON 260 VOM

Fig. 1. Electrical schematic for the Vidicon Minicamera.

voltage and when the unijunction firing voltage is reached, the unijunction conducts, discharging the capacitors. This generates a sawtooth at the emitter, a positive pulse at B 1, and a negative pulse at B 2. As we will see later, these waveforms will be very useful throughout the camera.

R 14 controls the charging current to the oscillator capacitors and therefore controls the frequency.

The saw waveform from Q 8 emitter is coupled to the base of Q 9, which amplifies and inverts the signal. A portion of the signal is taken from the emitter of Q 9 and fed back to the oscillator through the linearity pot, R 16, for improved vertical linearity. R 21 controls the gain of this stage and so controls vertical size.

The collector of Q 9 is direct coupled to emitter follower Q 10, which provides low impedance drive to the vertical deflection coils through a network consisting of C 14 and R 25.

Horizontal deflection

The horizontal deflection chain starts with an oscillator similar to the vertical oscillator, with R 28, R 29, and C 15 as the frequency determining elements. R 28 controls horizontal frequency in the same way as R 14 controls vertical frequency. The positive pulse appearing at B 1 of Q 13 is direct coupled to pulse amplifier Q 14. The inverted pulse is then capacitively coupled to the horizontal deflection amplifier, Q 15.

Due to the predominance of inductive reactance in the horizontal deflection coils at the line rate, the waveform supplied to the yoke must be a pulse of voltage to obtain a sawtooth of current in the yoke. This is why the horizontal deflection chain is a pulse type amplifier.

When Q 15 is turned off by the pulse from Q 14, the stored energy in L 3 is released, providing a large spike of voltage to drive the yoke. R 34 controls the size of this spike, and hence the horizontal size. C 17 tunes the output for maximum efficiency, and D 3 serves as the damper diode.

High voltage power supply

Since the vidicon requires operational voltages in the +300 and −100 volt regions, and only 12 volt input power is available, some type of dc-dc converter is required. The converter used is a simple stored-energy type which is driven from the horizontal deflection circuit. The power supply receives a pulse from the horizontal pulse amplifier, which turns Q 16 off. When Q 16 is cut off, a very large spike appears on the collector due to the release of energy which is stored in L 4.

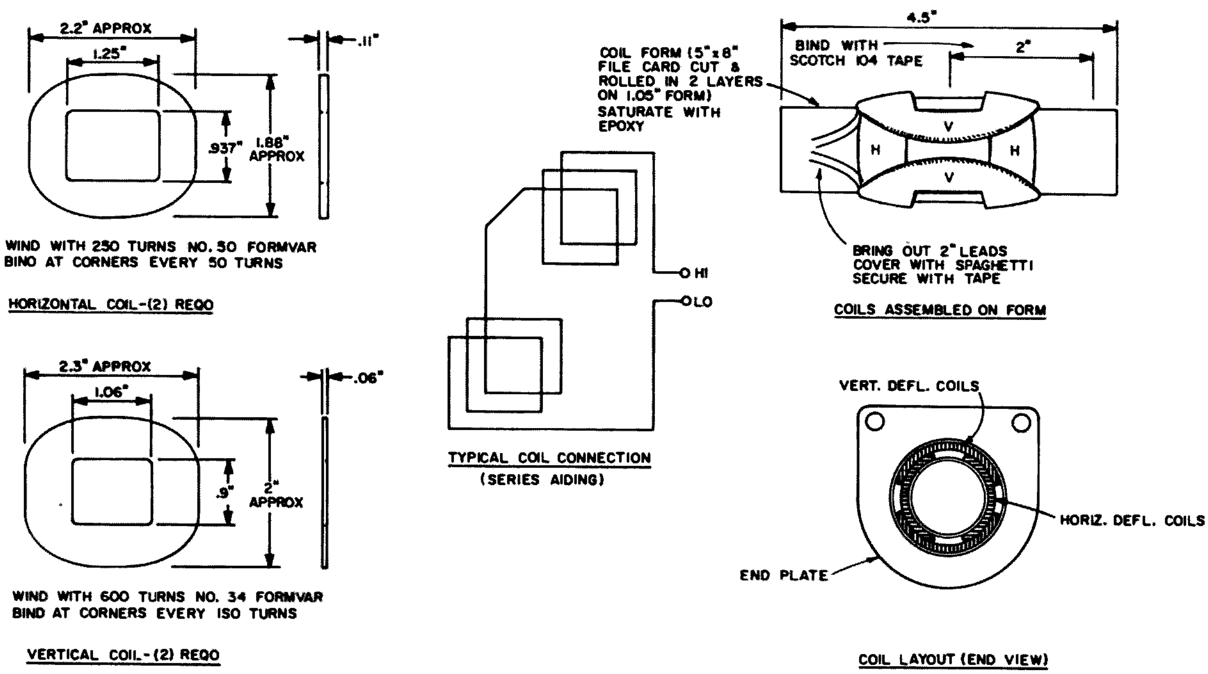
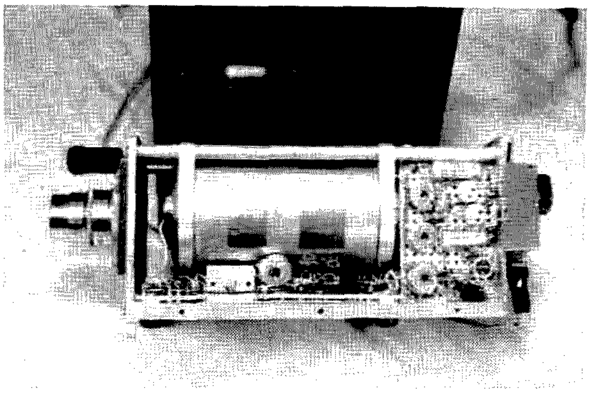


Fig. 2. Deflection coil data.



Looking inside the Vidicon Minicamera.

The pulse at the collector of Q 16 is rectified by D 8 and filtered by C 24 to provide the −100 V for vidicon beam control. This same pulse is multiplied by the ratios on L 4, and is then rectified by D 7 to provide +300 for anode and mesh power within the vidicon.

Diodes D 5 and D 6 are 150 V zeners which regulate the output of the power supply to 300 volts.

Vidicon circuits

The only external controls on the camera are the beam, focus, and target controls. These 3 controls adjust the operating parameters of the vidicon. The beam control sets the grid bias on the electron gun in the vidicon. Optimum setting of this control will allow just enough beam current to land on the photosensitive surface to replace the highlight current lost to the load resistor and target supply. Keep in mind that the beam control has an effect on vidicon life, and should always be kept at the minimum beam (maximum negative voltage on G 1) position when any abnormal condition could occur in the vidicon parameters. This would include camera turn-on, turn-off and especially during any kind of sweep failure, as the photosensitive surface is easily damaged. During normal operation, the beam should be turned up just enough to discharge the highlight whites in the picture.

While the major part of the beam focussing is accomplished by the electromagnetic focus coil around the vidicon, a small vernier focus is available electrostatically by varying the voltage supplied to the vidicon focus anode. This voltage is supplied through R 39, the focus pot on the camera, which is adjusted for maximum picture detail.

The vidicon target requires a voltage of from +5 to +65 volts depending on tube characteristics, light level, and ambient temperature. This voltage is supplied through isolating resistor R 43 from R 41, the target control on the rear of the camera.

Since the vidicon is a storage type tube, the beam must be prevented from landing on the photosensitive surface during retrace time. This is accomplished by the blankers Q 11 and Q 12.

When vertical blanker Q 11 receives the negative pulse from the vertical oscillator during retrace, this stage conducts, pulling the cathode of V 1 up to the +10 V buss, thereby cutting V 1 off.

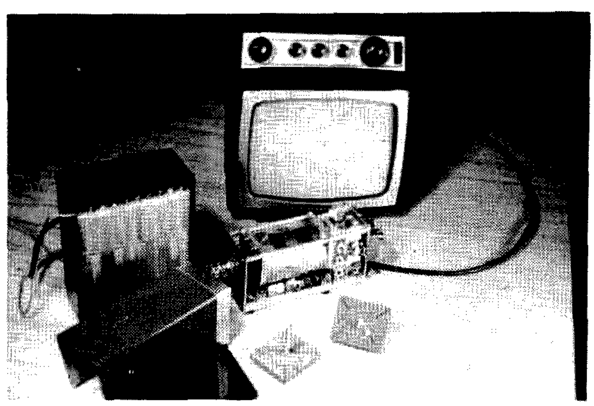
The horizontal blanker, Q 12, works in the same manner. It should be noted that either Q 11 or Q 12 can control beam cut off.

Diodes D 1 and D 2 prevent blanker conduction due to the small drop across R 17 and R 30 during scanning time.

Low voltage regulator

Since the camera is designed to operate from storage type batteries whose potentials may vary widely during charge and discharge cycles, and camera stability is considered important, a regulator circuit is included to hold the +10 buss reasonably constant over input fluctuations from approximately 10.8 to 14 volts.

Q 18 is connected as a difference amplifier which compares a portion of the 10 volt regulator output to a fixed reference, supplied by D 4. This amplifier controls Q 17, which is operated as an emitter fol-



The complete camera system. The black box is the battery pack using NICAD cells. The two rectangular pieces are coil forms for winding the deflection coils.

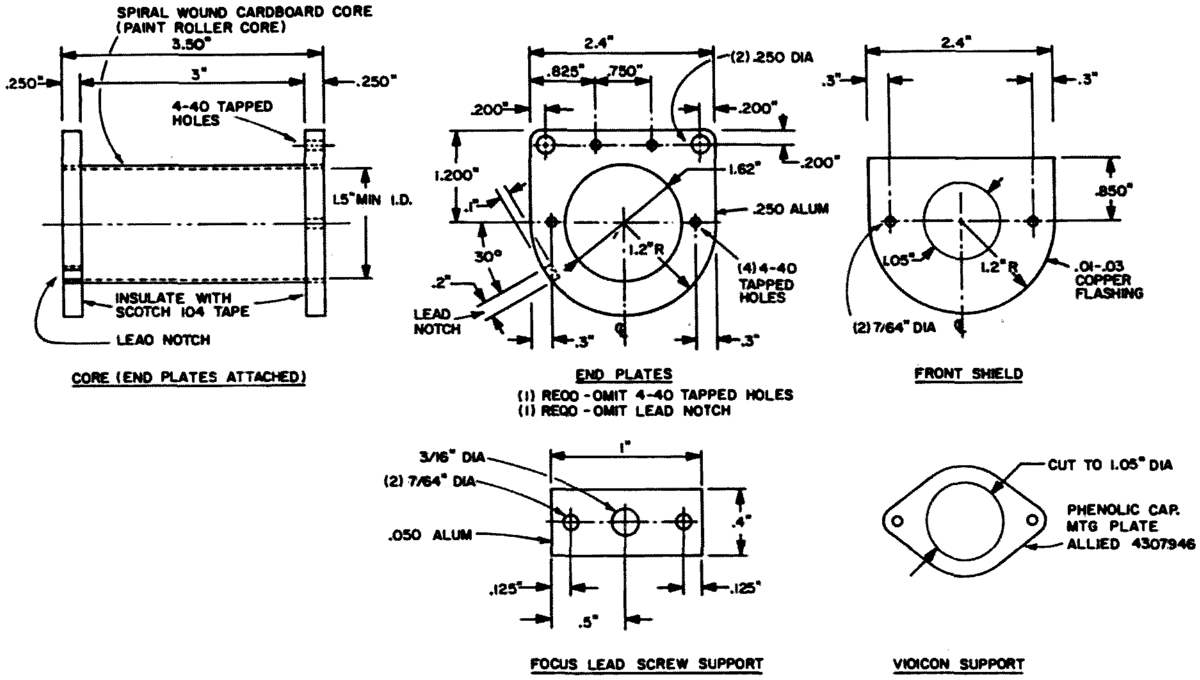


Fig. 3. Detail for the focus coil core.

lower pass transistor, R 35 controls the percentage of feedback and therefore, the potential on the + 10 V buss.

Power for the camera

In as much as the camera is designed for extreme portability, storage batteries are a natural choice for power.

Two types of cells have been found satisfactory, rechargeable alkaline, and nickle-cadmium, 3 Eveready #563 connected in series will do nicely, at moderate cost. 10 surplus nicad cells have been used very successfully.

Deflection and focus assembly construction

The deflection and focus assembly is designed to operate with low power input, and allow complete compatibility with the camera design philosophy, both mechanically and electrically.

Construction details for the deflection assembly are outlined in **Fig. 2.** The focus coil consists of 2600 turns of #25 Formvar wound on the focus coil core shown in **Fig. 3.** After the focus coil is wound, insulate with Scotch # 104 tape, and cover with a double thickness of conetic foil.

Camera construction

The electronic circuitry for the camera is divided into 5 basic sections, which are built up on the No. 85G24EP Vectorboard. Since the component density is high within the camera, neat a nd precise layout is essential.

Smaller and cheaper equivalent semiconductors have become available since this camera was built, and some consideration might be given to these, but keep in mind that the camera has been well proven in its present form.

The cases of most transistors used are connected to the collector, so be sure no shorts exist between cases and nearby components.

As the boards are completed, they should be tested in the manner outlined in the test procedure.

After the boards are tested, camera assembly can be started. The use of the .250 inch baseplate results in a very solid unit. The .250 diameter rods at the top serve two purposes, providing extra rigidity, and also providing a stable track for the moveable vidicon assembly to slide upon.

The board containing video, blanking, and sync circuitry is mounted on the baseplate below the focus coil area.

First, an insulating sheet is cut from a file card to fit between the video board and the baseplate. The video board is then mounted to the baseplate, using spacers drilled and cut from Vectorboard, and 4-40 screws through the drilled holes in the video board corners. It will be necessary to clip all T 28 terminals at a point just below the board to clear the baseplate.

The vertical and horizontal deflection boards can now be mounted using cut-down grounding lugs soldered to the lower corner terminals, and 4-40 screws.

LV regulator and HV power supply installation can now be accomplished. These boards slide between the vertical and horizontal deflection boards in the positions indicated, and are supported by the projecting ends of the pins in these boards. Any interfering terminal ends should be clipped. All possible board interconnections should now be made.

The vidicon socket can now be wired. This is a two-piece assembly, and the rear part should be removed and discarded to provide clearance. The socket should be wired to the previously installed boards with lead lengths appropriate to allow freedom of motions from the rear cover to approximately .750 inch forward of this position. C 22 is wired directly from pin 6 to the ground end of C 29 on the video board.

All leads from the boards and vidicon socket to the control panel should now be pigtailed out and the rear endplate installed with all pigtails brought through the large hole.

All connections should now be made to the control panel, leaving enough slack for accessibility.

P 1 is made by modifying a cinch 8S M socket. This is done by soldering leads into the socket to make a mating plug. Scrap transistor leads will do nicely. First tin in the leads, force them down into the plug, and heat the plug pins from the rear to fuse the leads into the socket. Cut the leads off evenly, add a piece of # 16 wire to the center of the plug, and P 1 is complete. P 1 is now cemented to the control panel.

Now install the front endplate, vidicon, focus, and deflection assembly, and slide rods. The front endplate should be painted flat black before assembly.

Check and finish all interconnections, and install the lens mount and lens.

The lens mount shown in the picture was turned from .250 aluminum stock on a thread-cutting lathe. An easier solution to the lens mount problem is to use the unit shown on the parts lists, with the frontplate drilled and tapped to match.

The camera is now ready for the tests described in the system test procedure.

Test Procedure

Board checkout

To avoid vidicon damage, the scanning circuits must be thoroughly checked out before vidicon installation.

To make checkout less complex, each board should be tested as soon as it is completed. Assemble the LV reg. board first, so it can be used to power the other modules.

To test the LV reg. board, first parallel C 19 with a 50 ohm 5 W load resistor. Next apply + 12 V from battery to Q 17 collector through a 1 amp fast-acting fuse. Battery minus goes to the minus side of C 21.

Now, with a meter connected across C 19, R 35 should vary the voltage from less than 9 V to more than 10.75 volts. Leave final setting at +10 V. Remove load resistor.

After constructing the vertical deflection board, check with ohmmeter to be sure no shorts exist on the +12 volt line. After this test, apply +10 V power from LV reg. board, and apply scope probe to Q 8 emitter. Adjust R 14 and R 16 to obtain trace like **Fig. 4.**

Temporarily connect V yoke and set R 21 and reset R 16 and R 14 for trace (**Fig.** 4) at junction R 25 and yoke lead.

When the horizontal deflection board is completed, check for shorts, apply 10 V, and connect scope to Q 13 emitter. Adjust R 28 for **Fig.** 4 trace. Temporarily connect H yoke, L 5, and set R 34 for trace similar to **Fig.** 4 at yoke lead.

To check out the HV supply it will be necessary to have the horizontal deflection circuit operating. Check for shorts, temporarily connect a wire from C 27 to Q 14 collector, and fire up the horizontal deflection circuit.

Apply 10 V to the HV board and check for a pulse similar to **Fig. 4** at Q 16 base. Unless a low-capacitance probe is

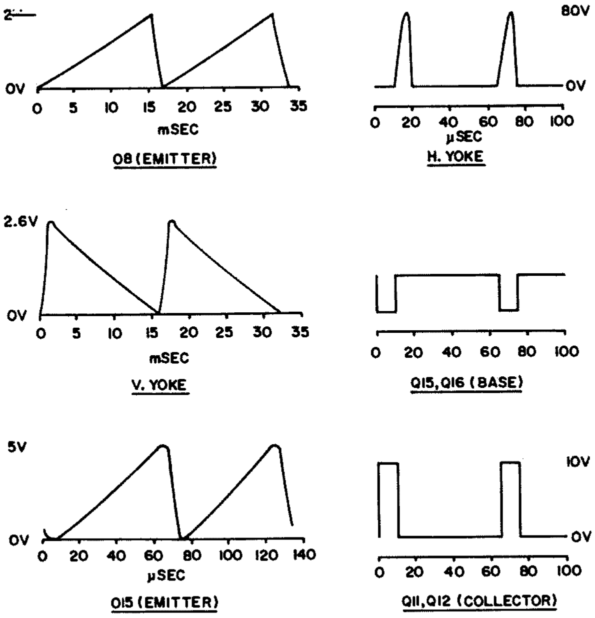


Fig. 4. Scope waveforms used in making the various adjustments in test procedure.

available, the scope will load any readings taken on the HV transformer, so it probably is best to take output at the dc terminals with a VTVM. Check for +300 ± 30 V and −100 + 40 −10 V with VTVM.

Video board tests should now be held to voltage checks, with signal readings taken during camera system checkout.

Camera system checkout and adjustment

After all board inter-connections have been thoroughly checked, test across C 19 for shorts. The resistance here should be approximately 20 ohms, using a Simpson 260 VOM with the common lead to ground. Make sure the vidicon is disconnected. Connect the 12 V source to P 1, turn power on with S 1, and adjust R 35 for + 10 V at Q 17 emitter.

Now test all points listed in the board checkout procedure for similar voltages and scope waveforms.

We are now ready to connect the video output to a monitor, either directly or through a pretested "jeep", (A unit used to convert video to one of the TV channels).

A rough check of video board operation can be made by holding a finger near the vidicon target lead. Now, vary R 6 to obtain noise on the monitor. When the above tests are satisfactorily completed, turn the power off and plug in the vidicon. Preset the beam and target controls to minimum and the focus control to midrange. Now reapply power, adjust vertical and horizontal frequency controls to sync the raster, and advance the target and beam controls until the monitor flashes with the beam control.

Set up a test pattern, open the lens iris, and it should be possible to see the first glimmerings of a picture on the monitor screen.

Set up the test pattern 18 inches from the lens, and a 60 watt bulb behind the camera. Put a dark cloth over the top of the camera to prevent stray light from falling on the vidicon faceplate.

Now adjust mechanical (optical) focus, electrical focus, beam, and target controls to obtain the best picture. The image will probably be distorted with some streaking at this time.

We are now ready to make final adjustments. Connect the scope vertical channel to the junction of R 25 and the yoke lead, and supply a 60 Hz signal to the horizontal channel.

Adjust R 14, R 16, and R 21 to obtain full vertical height and good linearity on the monitor, with a single, nearly stationary pattern showing on the scope.

Now move the vertical scope input lead to the junction of C 18 and the yoke. A stable 15.75 kHz reference for the scope horizontal can be provided by a well-insulated lead draped over the horizontal output tube of a nearby TV receiver synced to a local station.

Adjust R 28 and R 34 for a full picture on monitor, and the single, stationary pattern on the scope.

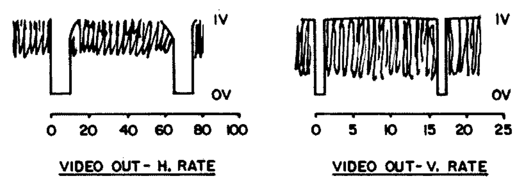
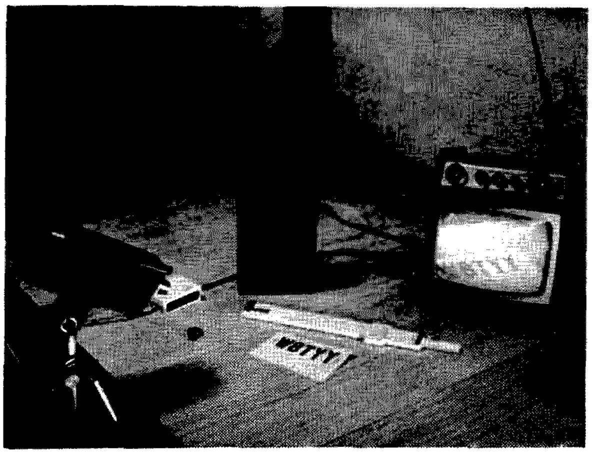


Fig. 5. Horizontal and vertical output forms.

Now connect the scope to the video line, and adjust R 6 and R 27 for a waveform as shown in **Fig. 5.** Rotate the deflection yoke inside the focus coil to obtain the proper image orientation. Reverse the yoke leads to correct for image reversal. Set C 3 for minimum streaking following the heavy horizontal bars on the test pattern. Readjust R 6 for **Fig. 5.**

This completes camera checkout.



The Vidicon Minicamera in action. The monitor is a modified Philco N1052BK solid state receiver.

Parts List

Resistors

All resistors ¼ W 10% unless noted

R 1	1 M
R 2, R 8, R 12	820 ohm
R 3	1.8 K
R 4, R 32, R 47	1 K
R 5	3.9 K
R 6, R 27, R 34	1 K Pot Mallory MCT—4
R 7, R 11, R 45	100 K
R 9	82
R 10, R 36	2.7 K
R 13, R 22, R 23	470
R 14, R 28	10 K Pot Mallory MCT—4
R 15, R 38	10 K
R 16	5 K Pot Mallory MCT—4
R 17, R 30	270
R 18, R 31	220
R 19	56 K
R 20	33 K
R 21, R 35	2 K Pot Mallory MCT—4
R 24	390
R 25	33
R 26	8.2 K
R 29	6.8 K
R 33, R 46	2.2 K
R 37	100 ohm
R 39, R 41, R 44	2 M Pot CRL BK-122
R 40	2 M
R 42, R 43	10 M

Capacitors

All capacitors in microfarad unless noted

C 1, C 23	.001-200 V	Sprague Type 192P
C 2	.0027-200 V	Sprague Type 192P
C 3	170-780 PF	Elmenco 469
C 4	20 PF Disc. Cer.	
C 5, C 18, C 29	10-12 V	Sprague TL1128
C 6	300-3 V	Sprague TE1066
C 7, C 8	10-10 V	Sprague TE1114
C 9	200-12 V	Sprague TE1137
C 10, C 14	100-10 V	Sprague TE1119.3
C 11	5.6-6 V	Kemet K5R6C6K
C 12	3.9-10 V	Kemet K3R9C10K
C 13	.68-35 V	Kemet KR68C35K
C 15	.0068-200 V	Sprague Type 192P
C 16, C 27	4-25 V	Sprague TE1201.2
C 17	.0033-200 V	Sprague Type 192P
C 19	200-10 V	Sprague TE1119.6
C 20	3-12 V	Sprague TL1122
C 21	50-10 V	Sprague TE1119
C 22, C 25	.047-400 V	Good all type 663vw
C 24	.1-200 V	Sprague Type 192P
C 26	.05-200 V	Sprague Type 192P
C 28	20-12 V	Sprague TE1130

Coils

L 1	15 Microhenry	RF choke, Miller	9310-40
L 2	560 Microhenry	RF choke, Miller	9350-26
L 3	10 Millihenry	RF choke, National	R-40-10
L 4	HV XFMR	1200 T #34 on ¼" iron-slug form. tap at 400 T.	
L 5	H yoke		
L 6	V yoke		
L 7	Focus coil		

Transistors

Q 1	2N4304	Amelco
Q 2, Q 3, Q 4, Q 5, Q 6, Q 7, Q 14, Q 18	2N706	RCA
Q 8, Q 13	2N1671	G-E
Q 9, Q 10, Q 15, Q 16, Q 17	2N1613	RCA
Q 11, Q 12	2N404 or 2N3638A	RCA-Fairchild

Diodes

D 1, D 2	1N645	G-E
D 3	1N91	G-E
D 4	1N709A	TI
D 5, D 6	1N989B	Motorola
D 7, D 8	1N 4005	TI

Switch

S1 — Alco MST 115D

Indicator

DS1 — Sylvania 10ASB

Connectors

P1 Subminiature socket	Switchcraft 3501FP
J1 Phono Jack	(Modified) Cinch 8SM (2 Rqd.)
Vidicon Socket	Cinch 8 VT

Miscellaneous Hardware

Approximately 30 440x¼ bright nickle mach. screws
One 85G24EP Vectorboard
100 No. T 28 Vector terminal
One chassis bottom plate Bud BPA-1596
Four rubber foot—G-C # HO52-F
.250 Aluminum
.090 Aluminum
Two 6"x.250 steel rods (available at hardware supply)
One 1.25x10-32 pan head screw (focus lead screw)
One light spring to fit 10-32 screw
Cardboard tube 1.62 OD See fig. 4
Cardboard tube 1.05 ID See fig. 10
1¾ lb. # 25 formvar magnet wire
½ lb. # 30 formvar magnet wire
½ lb. # 34 formvar magnet wire
One sheet 16x3x.004" conetic foil, conetic AA, made by Magnetic Shield Div., Perfection Mica Co.
Lens, Cinepar 25.4MM (1 in.) FL F/2.5 Edmund Scientific, # 40, 724
Lens mount, #SCM, available from ATV Research, PO Box 396, So. Sioux City, Neb.
Test Pattern 6.75"x9"

. . . W8TYY

Robert E. Baird W7CSD
3740 Summers Lane
Klamath Falls, Oregon

The Little Gem Fuse Tester

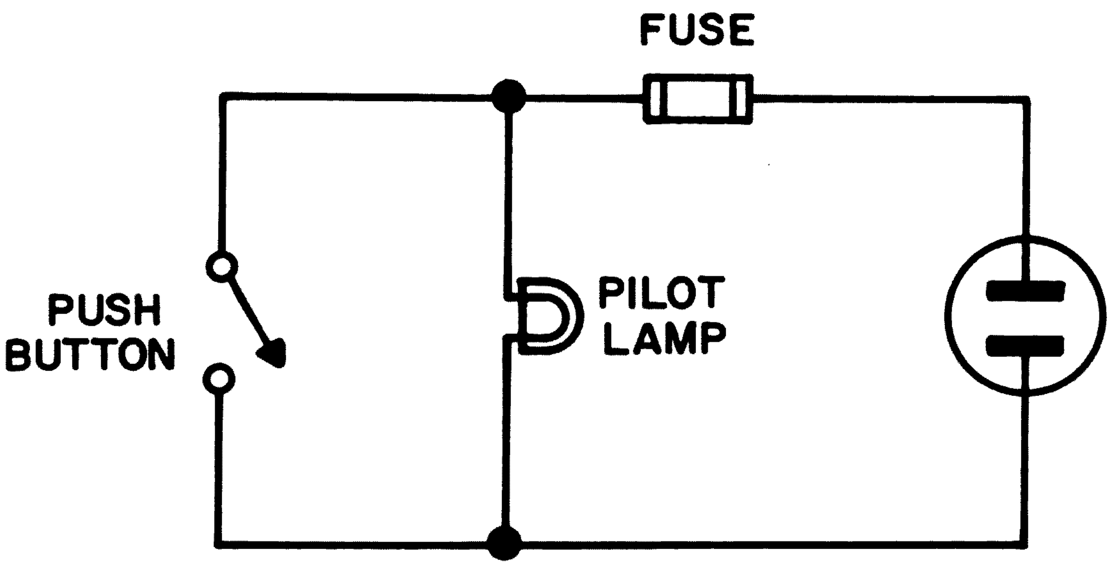


Fig. 1. Diagram for the Little Gem Fuse Tester.

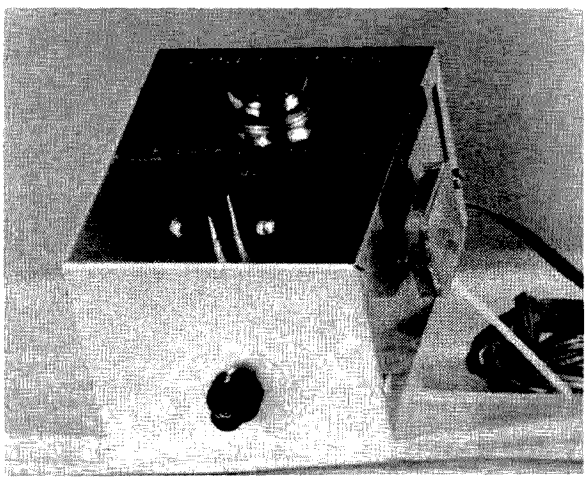
Here's an oldie that we haven't seen around for ten or fifteen years. There are several versions of this little first-day-of-April gadget. Ours calls for a neat little Minibox, a nice big bull's eye pilot light (110 Volt variety), a fuse in it's holder, a push button, a spare fuse container with spare fuses, and a cord with a plug.

On ours, we put the title "Little Gem Fuse Tester" on a plastic label at the top. In the center, we put "If lamp lights, fuse is good". There is no label on the push button. Everyone has an uncontrollable urge to push a button. If you push the button, of course, the fuse is blown and the light goes out.

There are several approaches to the use of this "Little Gem". One way is to simply lay it on an associates desk or work table. He will probably come in, pick it up, plug it in, and try it out. As soon as he realizes that he has been had, he will put it on the next person's desk. The spare fuse container may have to be refilled a time or two during the day. One variation is to leave out the fuse, in which case the building fuse blows and possibly the lights go out. Some administrative personnel may take a dim view of this!

In our case, we made out a very official interdepartmental memo stating that we needed some lay experimenters to determine the value of the device. Then on a second sheet (not to be read prior to experimenting) we put a bunch of questions like, "Was the fuse good?", "Is it still good?", etc. All leading up to a "Happy first day of April to you".

. . . W7CSD



The Little Gem in operation.

John J. Schultz W1DCG
40 Rossie St.
Mystic, Connecticut 06355

Methods of Transceiver CW Switching

Most transceivers which operate on CW, still have an awkward means of send/receive switching on CW, while SSB operation is made convenient by means of push-to-talk or VOX circuits. A number of ideas are presented on how to make transceiver operation more pleasant for the CW man. Most transceiver manufacturers seem to make a point of neglecting the needs of the CW operator in their designs. Even those models which cover the CW portions of the bands, lack sharper selectivity for CW, a keying monitor, and a convenient means of send/receive switching in the CW mode. Most transceivers which do operate on CW, require that a rather awkward panel switch be thrown every time for send/receive switching. At least for phone operation, a push-to-talk or VOX switching circuit is provided, but the CW operator is still left with the old-fashioned, panel type send/receive switch.

Besides the plain inconvenience involved in handling the switch for each transmission changeover, the panel around the switch usually begins looking worn very quickly, since the switch becomes the most frequently handled control.

The value of extremely fast break-in operation for the average CW operator, who does not engage in traffic handling, is probably debatable. Therefore, the simple circuits described in this article may not satisfy the avid traffic man, but should meet the needs of other CW operators.

The send/receive or SSB/CW switch, (as it is usually labelled on most transceivers),

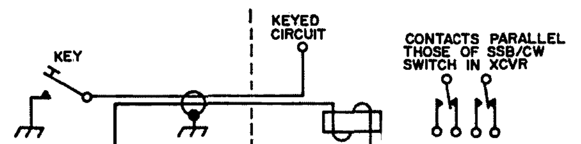


Fig. 1. Simple placement of push switch at the key to control transciever.

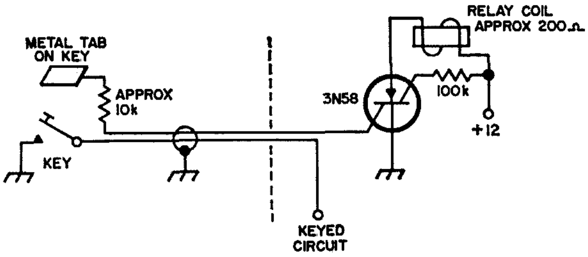


Fig. 2. Use of a hand capacity circuit to activate the CW switching relay.

usually performs several functions:switching of circuit relays (such as those for meter switching and antenna transfer), carrier oscillator offset, opening of the keying circuit and carrier insertion. The latter function may be accomplished, on some transceivers, by simply turning the carrier balance control to one side.

These switching functions are usually controlled by the equivalent of a DPDT to 4PDT switch configuration. This can easily be determined from the transceiver schematic. The simplest method for providing easier send/receive switching on CW, is to use one or two miniature DPDT relays, installed inside the transceiver, and wired to parallel the contacts of the SSB/CW switch.

Remote control of the relays can be provided by replacing the usual 2 circuit key jack with a 3 circuit key jack, using a 2 wire shielded cable to the key, and installing a sub-miniature toggle (or push-to-make push-to-break) switch on the key base. Sub-miniature switches, such as the Alcoswitch types MST-115D and MSP-205N, are particularly suitable and are readily available. A foot switch from a tape recorder can also be used for control.

For those who want to eliminate a remote control switch entirely, several methods of control can be used. One method involves the use of a hand capacity circuit, utilizing a silicon controlled switch as shown in **Fig. 2.** Hand capacity on the contact tab will cause the SCS to conduct and energize the relay coil. The contact tab can be a small

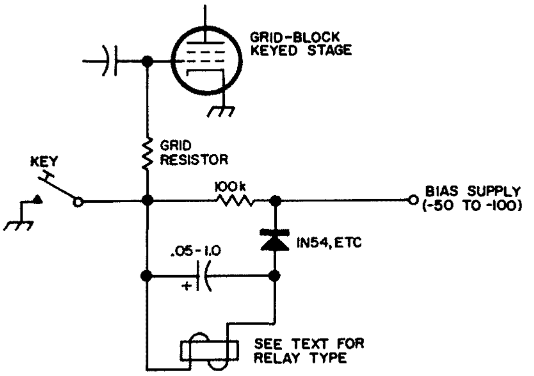


Fig. 3. Placing a high resistance relay directly in the keyed bias line may provide a very simple switching means with a time delay determined by the size of the capacitor across the relay coil.

piece of metal placed on top or the side of the key paddle. Both resistors can be varied in value to control the sensitivity of the circuit and will probably need initial adjustment depending upon the capacity to ground of the control lead in the keying cable from the transmitter, and the characteristics of the particular relay used.

More stable operation may also be obtained if a grounded metal surface is placed so that it makes contact with the edge of the hand which manipulates the keying paddle. With *this circuit*, placing a hand on the key or removing it from the key will automatically control the relay action.

Another method for relay control which requires no external control wiring is shown in **Fig. 3.** A miniature high resistance relay, such as a Phillips MK/2C/5000D or similar type, is necessary. The contacts of the relay are wired to parallel those of the SSB/CW switch in the transceiver. The coil of the relays(s) is wired across the current limiting resistor in the bias line to the keyed stage in a grid-block keying system. Closing of the key will energize the relay(s) as well as turn on the keyed stage. The capacitor across the relay coil(s) will charge quite rapidly because of the low resistance of the bias voltage source, and the high resistance of the relay coil(s). When the key is opened the charge across the capacitor will keep the relay(s) energized for a period which is determined by the capacitor size and the relay coil characteristics.

By experimenting with the capacitor size, a delay, from a fraction of a second to several seconds or longer, can be obtained to suit any keying speed. If a variable delay is desired, a 500 K ohm potentiometer can be placed in parallel with the capacitor.

The diode in the circuit prevents discharge of the capacitor through the current limiting resistance, and also distortion in the keying waveshape on the break portion of the keying sequence due to delay in having the bias voltage cut-off the keyed stage.

Still another method of switching which works basically the same as the preceeding method as far as relay action is concerned, but provides several additional functions and advantages is shown in **Fig. 4.** Transistor Q_1 is used as a switch to close the keying circuit in the transmitter, instead of the key contacts directly. The voltage across the key contacts is considerably reduced and sparking is essentially eliminated. The keying waveshape characteristics can be controlled by changing the resistor/capacitor combination in the base of Q_1. Transistor Q_2 acts as a simple switch to energize the coils of the relay which performs the SSB/CW switching functions.

As with the circuit of **Fig. 3**, the size of the capacitor across the relay coil determines the time delay range. Transistor Q_3 acts as another switch to energize the simple CW monitor circuit of Q_4.

The entire circuit, except for the relays, can be built into the transceiver, if space is available, or, otherwise, in a separate Minibox. A battery supply can be used for the necessary voltages, with a miniature speaker

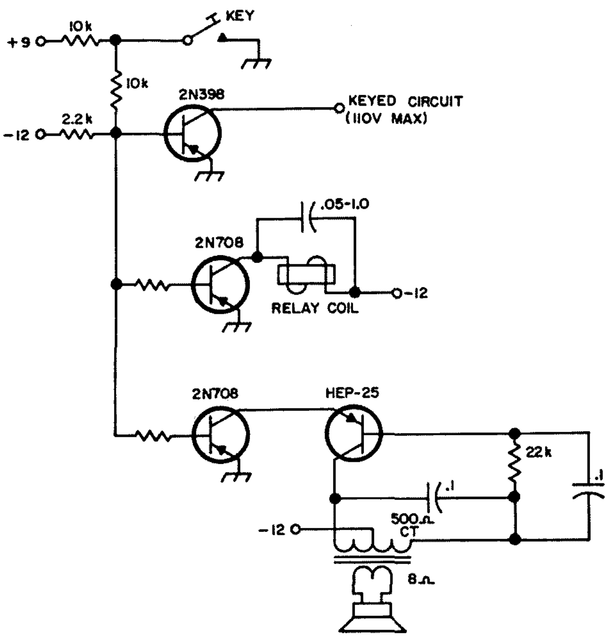


Fig. 4. Manual key controls three transistor switches which energize keying circuit, relay switching and CW Monitor.

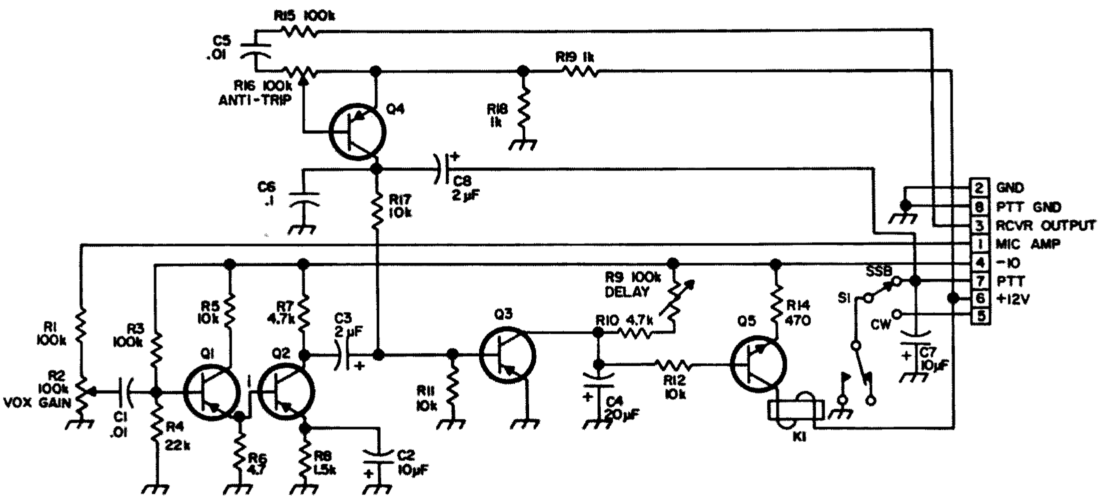


Fig. 5 Addition of switch to the Swan VX-1 VOX.

for the CW monitor; thus reducing the external wiring required.

Perhaps the simplest switching circuit of all can be devised by using the VOX circuitry of a transceiver which has such a feature. For instance, Fig. 5 shows the schematic of the Swan VX-1 VOX unit, which is generally similar to a number of tube or transistor accessory VOX units.

For CW operation, the features of the same VOX unit can be utilized by installing a switch (S, in Fig. 5) so the VOX relay either controls the PTT circuit on SSB, or the coil of a relay which parallels the SSB/CW switch contacts inside the transceiver.

Since the first audio stage in the Swan 350 remains energized on CW (the second stage is de-energized), an audio tone, fed into the microphone input, will operate the VOX unit. This audio tone can simultaneously be used for CW monitoring as shown in Fig. 6. Thus, with a relatively simple modification, one can have all the advantages of the VOX unit on CW as well as on SSB.

It should be noted that since the keyed tone only activates the VOX unit and is not used for carrier generation, as with some keying systems which utilize an audio tone fed into a SSB transmitter audio input, its waveshape is unimportant.

Many of the above suggested switching systems were tried with a Swan 350 transceiver. However, if the reader first carefully examines the schematic for another transceiver to determine exactly how the SSB/CW switching functions are accomplished, there should be no difficulty in adapting any transceiver for much more convenient send/receive switching on CW.

. . . W1DCG

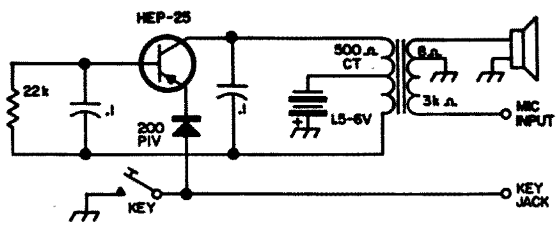


Fig. 6. Simple keying monitor/tone unit for use with a transceiver for CW operation.

"Never mind how she became interested in shortwave, if she's married, how old she is, and the color of her eyes—just give her our location."

Operation Santa Claus

Operation Santa Claus, one of the largest single-day charity drives in the world, was held in Des Moines on December 14, under the sponsership of the Des Moines Radio Amateur Association and the Central Iowa VHF Club. The eighteenth annual Operation Santa Claus filled a Volunteers of America warehouse with food, toys, clothing, and everything else imaginable.

From 12:30 in the afternoon, until 7:00 at night, Radio Station KRNT put out requests for anything which might brighten the Christmas of someone less fortunate. Over 1,100 calls, on five phone lines, came in to the KRNT studio in this 6½ hour period. Hams in the studio dispatched calls on three bands over equipment remotely controlled from the studio. Calls were dispatched directly to cars and also to two fixed stations. Hams not having mobiles were also pressed into service because of the large volume of calls. The non-mobiles went to the fixed stations and picked up addresses there.

Thirty mobiles, and eight cars without radios were in use throughout the afternoon and evening.

The Dės Moines Club was assisted by several cars from the Newton, Iowa Club. As in past years, one of the cars was driven by ARRL President Bob Denniston, WØNWX, who was participating in his 10th consecutive Operation Santa Claus.

In all, over 1,800 miles were driven by 38 cars while handling over 1,100 calls. The eighteenth annual Operation Santa Claus was a great success because the Christmas of 700 Des Moines area families was made a little brighter. ■

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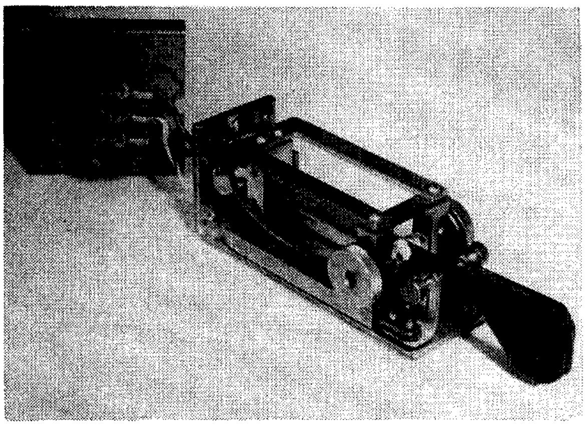
A. E. Oliver, Jr., K4YWS
155 Poydras Avenue
Mobile, Alabama, 36606

The Polar Key

73 Magazine has presented many fine articles on constructing automatic keyers, and details for devices to actuate these keyers. However, the mechanical parts seem to present a problem to the average ham and the services of an experienced, well equipped machinist are required to fabricate the metal parts of most. Those that do not require these precision parts often look a little "too homebrew", and make no provision for the adjustments that a CW operator needs to create the right "feel" in his key.

The mechanical key described in this article was devised to solve these construction problems. In addition, lever tension and contact spacing may be adjusted, as desired, for good smooth operation.

The "heart" of this key is obtained from the W. E. 255A Polar Relay. These relays are available from a number of surplus dealers for about $2.50. The relay need not be in operating condition for its' designed purpose, and a defunct relay can be used. There should be no missing parts, however, except the coil assembly and the case. Do not overlook the possibility of your junkbox, or of obtaining one from a friend on RATT. The entire project should not cost over $3.50; much less if a relay can be borrowed.



Looking inside the Polar Key.

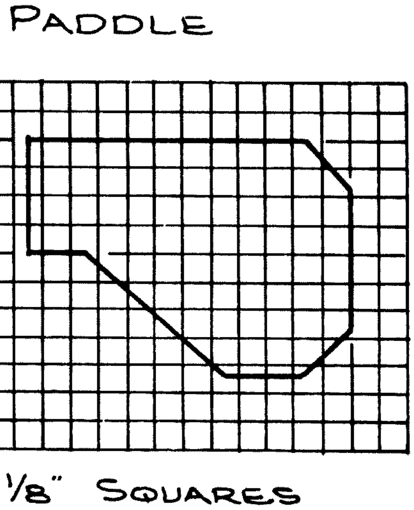


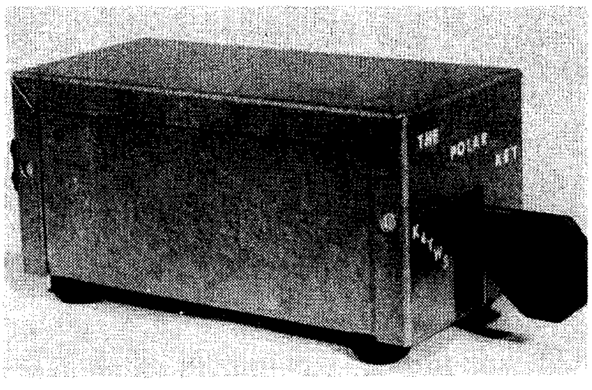
Fig. 1. Design for the Polar Key paddle.

The following additional parts will be required; a small ignition file, a 2-1/4 by 2-1/4 by 7 inch Mini-box, four rubber mounting feet, and two small circular pieces of foam rubber, such as those used for ladies' earrings.

Now, on with the construction! First, remove the relay from its' housing and base. Disconnect the coil and contact wires from the rear terminals. Remove the coil and lever armature assembly. This is done by removing the top part of the relay frame, two small screws securing the lower front part of the coil, and loosening the metal plate holding the rear end of the lever armature.

Cut the two sides of the paddle assembly, as shown, from some type of stiff insulating board. Fibre epoxy works well. Affix these two paddles on each side of the rough end of the ignition file, using epoxy. Clamp firmly until set. Shape the handle end of the file, and slip this end into the space formerly holding the lever armature. Align the lever with the front contacts and tighten the metal plate firmly.

Attach the foam rubber pads to the ends of the spacers that are attached to the large



The final package.

knurled knobs. Use glue that will not dissolve the foam rubber. The ignition file, now serving as a lever, will reset between these two rubber pads, and will allow adjustment of side tension on the lever. This will also dampen any unwanted vibration of the keying lever.

Mount the completed key in the Minibox, using the holes in the bottom of the relay frame. Make a cut-out in the front of the Mini-box cover, to allow space for the paddle and lever. Install the four rubber mounting feet. Rough the bottom of these feet, with a file, to give a better grip on top of your operating surface. Mount a three connection terminal on the rear of the Minibox cover. Connect the three wires from the relay to this terminal. The white wire should be in the center, and will serve as common ground. The red and white wires go to either contact, for selection of "dots" and "dashes".

Now adjust the keying lever tension and contact spacing to suit your "fist" and install the top cover.

You now have a nice looking mechanical key, with precision adjustments, and all for very little expenditure in time and money.

Many thanks to my friend, Holman Johnson, K4SRF, for his excellent photography.

Hope you enjoy "The Polar Key".

. . . K4YWS

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Checking Your VSWR Indicator

Many articles have been published on how to build and even some on how to calibrate a VSWR indicator. The calibration instructions usually tell you to terminate the indicator's output with a purely-resistive 52-ohm load and then to adjust the device so that a maximum forward and minimum reflected meter deflections are obtained. Sometimes they'll go further and tell you to reverse the device and recheck for opposite indications.

This is all very well. It assures you that the VSWR indicator will be telling you the truth when it says "All's well!" while looking into an utterly-flat transmission line. It doesn't tell you a thing about what the indicator will have to say when it gets tangled up with a line that has a wildly-mismatched termination.

As most transmission lines, in actual practice, are terminated in loads which are not only mismatched in the matter of resistance but also in the inclusion of a considerable magnitude of reactance, it would be well to explore the indications you'll get under realistic circumstances. After all, these are the situations under which you'd want to take corrective steps. Accurate indications of undesired conditions, therefore, are imperative if intelligent remedial actions are to be taken.

Fortunately, some quite enlightening tests are made easily. All you'll need are some lengths of coax transmission line (the same as you're using in your antenna feedline) equipped with male fittings at each end and a few female-to-female junctions. Select the frequency at which you want to make the test. Usually it's wise to make the test on the highest frequency band you plan to use. With this in mind, make up three one-eighth wavelength sections of transmission line and mount the male fittings on the ends of each section.

If your antenna presents an unmatched load to your transmission line, you may elect to skip over this paragraph and go directly to the next one. If it does not (Ah, you dreamer!), you'll need another piece of transmission line. It should be fairly long, perhaps a half wavelength. Put a male fitting at one end and attach a termination, which is deliberately made to be a sad mismatch, at the other end. Don't just mismatch it by using too high or too low a value of resistance. Throw in some reactance, too! You might use a resistor with an inductor in series. Or, you might try a capacitor in series with the resistor. Or, you could use either an inductor or a capacitor in parallel with a resistor. In fact, it would be best to experiment with all four!

Now that you have a transmission line available that you know is mismatched, you're ready to start the test. The first check (the "control", you might call it) is made with everything normal. That is, you'll have the transmitter feeding directly into the VSWR indicator's transfer box and the transmission line (either the one to your antenna or the substitute line to the mismatched load) attached to the output of the transfer box. Note the VSWR indicated. Also note your transmitter; insure that it's tuned to resonance and is adjusted to a power you can maintain throughout the first portion of the tests. Jot down these indications. Now, insert an eighth-wave section between the transfer box and the transmission line and without making *any* other changes or adjustments, note the VSWR. Repeat these steps, adding an additional eighth-wave section each time until you've used all three. Did you detect any change in VSWR? If there was even the slightest change, your VSWR indicator is not trustworthy!

Now for two more checks. Try varying the transmitter power output. Does this have any effect upon the indicated VSWR? If it does, your VSWR indicator is not trustworthy! Then try varying the transmitter output tuning, deliberately throwing the stage out of resonance. Does this have any effect upon the indicated VSWR? If it does, your VSWR indicator is not trustworthy!

Few VSWR indicators under the $150 class will pass these basic tests. If yours doesn't, don't be perturbed. You have an instrument that still has a useful field of application. You can use it as a comparative indicator. For instance, if you're adjusting the gamma match at an antenna, it'll serve quite well; in this application, you're holding all of the significant variables constant, with the exception of one (the gamma match), the effect of which you want to observe. Your tests will have shown you the parameters you'll have to hold constant for any other than simple comparisons. In all probability, you will have found that measurements taken with different (electrical) lengths of transmission line are invalid. Also, it's probable that, owing to the non-congruity of diode curves, measurements will have to be taken at precisely the same level of rf power if accurate comparisons are to be made.

If you'll keep its very real limitations in mind, you'll find that even an inexpensive VSWR indicator has excellent potentials for useful measurements. But don't ask it to perform at levels that even its expensive siblings can't attain!

. . . W5EHC

Ham Of The Year Award

The Federation of Eastern Mass. Amateur Radio Associations is now accepting nominations for the 1968 John Mansfield Memorial award "Ham of the Year". Only licensed amateurs in the 1st call district are eligible for this award and the candidate must be able to meet any one or more of the following qualifications.

1. Performed a meritorius public service to his community through amateur radio. 2. Made a major contribution to the science of amateur radio. 3. Helped greatly to stimulate interest in amateur radio in others. 4. Aided other radio amateurs to acquire a greater knowledge and skill in operating or building amateur radio equipment.

The winner of this award will be presented a plaque and a cash award on June 1, 1968 at the New England ARRL convention at the New Ocean House, Swampscott, Mass.

Send all nominations to Eli Nannis W1HKG, Chairman Awards Committee, 37 Lowell St. Malden, Mass. 02148. The closing date is April 26, 1968.

Robert J. Walker W8VCO
1849 Meadowlark Drive
Toledo, Ohio 43614

Video Mixing Amplifiers

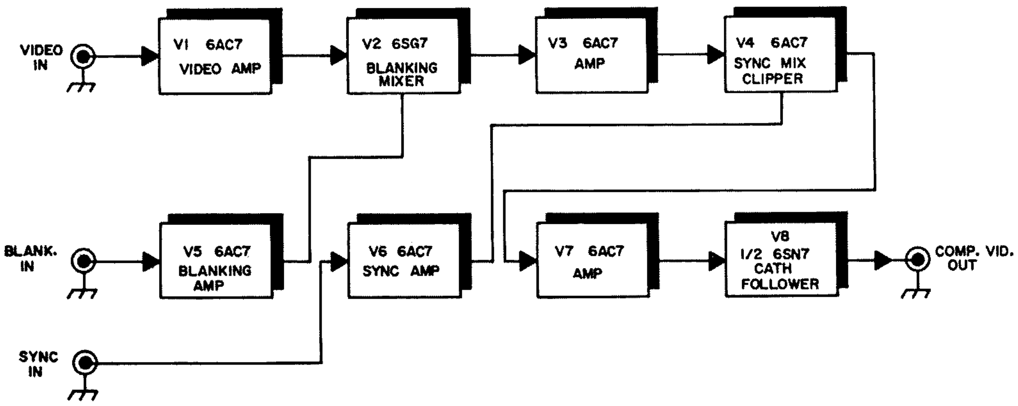

Fig. 1. Block diagram of the video mixing amplifiers.

In order to produce a good composite video signal, one must have a system for properly inserting all video information.

Hence the purpose of this article, which will describe video mixing techniques.

There are three inputs. First is the video from the camera, second the blanking from the blanking pulse generators, and third the synch pulses from the shaping generators.

Video is fed to VI whose output connects to V2. The gain control being at the input video connector. The video input being white negative.

The composite blanking is fed into V5. These pulses are negative going. A 1N34 is used in the grid circuit for clamping purposes. The plate of V2 and V5 are parallelled. Mixing of the video and blanking is achieved in this manner. Blanking amplitude is controlled in the cathode, and the cathode bias is monitored at TP2.

At this time, it should be mentioned that **Fig. 3** shows the test points and typical voltage values which can be expected. There will be a slight variation due to the aging of the tubes.

V2 is a Gamma control amplifier. For our particular case the voltage at TP1 was 0 volts. Our camera incorporates a vidicon tube, and no gamma problems were evident. Grid of V2 is also clamped.

Negative composite synch pulses are fed to V6. Synch level is set and monitored at TP4. The plate of V6 is parallelled with the plate of V4.

V7 is an amplifier and also an inverter stage so that the polarity of the composite video is correct. The 10 k pot in the cathode circuit acts as a gain control. The purpose is to prevent overdriving the cathode follower (V8) which is also the output stage.

Once the amplifiers are set up, it would be advisable to observe wave forms at each stage. These are shown in **Fig.** 4. It may

TYPICAL VOLTAGES

T P 1.	O.O V.D.C.
T P 2.	4.2 V.D.C.
T P 3.	5.5 V.D.C.
T P 4.	2.9 V.D.C.

FIG. 3. Test point voltages

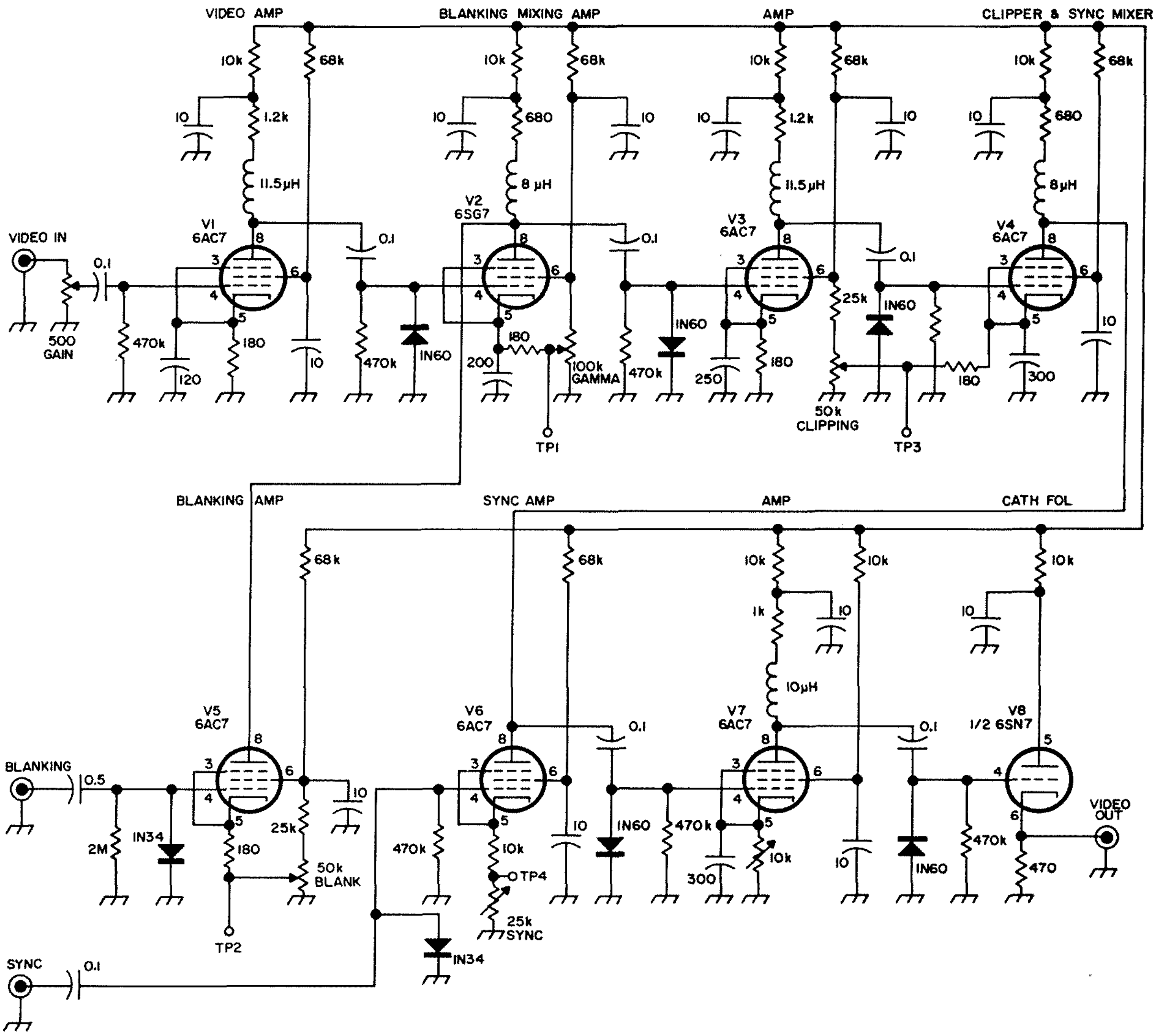

Fig. 2. The actual schematic wiring diagram of the amplifiers.

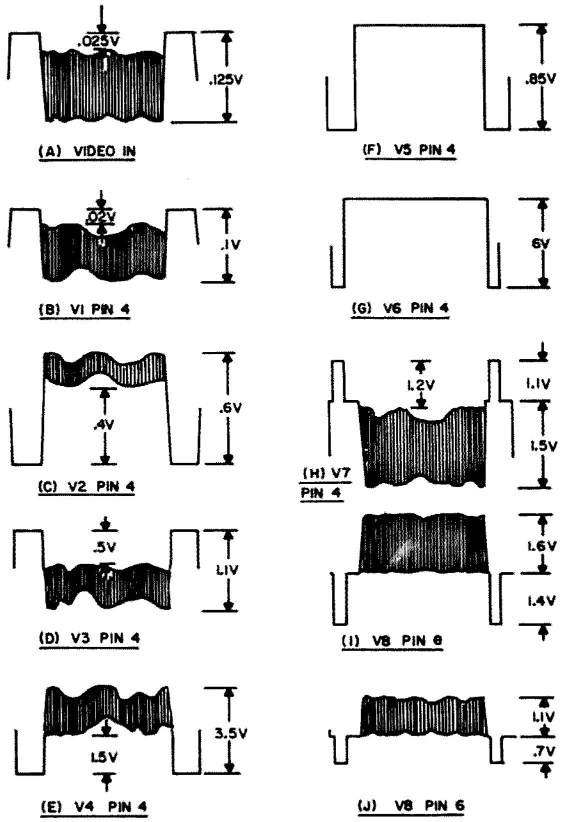

Fig. 4. Sine wave forms at each stage.

be necessary to trim the voltages at the test points to duplicate the wave form amplitudes and clipping levels.

Only the horizontal sweeps are shown. These are representative of what the vertical pulses should be.

The power supply should be well filtered and regulated.

Polarities of all clamping diodes must be observed.

These amplifiers have been in service for the last six years and have been maintenance free.

—W8VCO

Correction

An error has been found in the figures for the Ferris Wheel Antenna in the February issue. In the table on page 23 the figures for 7.3 MHz should be corrected. The loss resistance should be $4.43\text{x}10^{-2}\Omega$ and the efficiency figure should be 85%.

A Solid Dead-Man

"The Wild 'n wooly winds of worcester (and Shrewsbury), wrecked what Woolner wrought." (phew). Omar Kayam said it, I believe. He was a Persian poet who became a "Silent Pen" about 1130. You don't remember him, and neither do I. Only some of his scribblings remain to say how right he was.

He said, "There is nothing new under the Sun, everything that is, has been". I bet he referred to my tower—and I refer you to 73, July 1967, page 70 . . .

My tower "was" and is now a "has been" . . .woe is me. Now if I had been careful, and not in such a dad-gummed hurry, I would have put that third dead-man in a little more securely. The sad part is that it was up wind from the tower and it eased out of the ground a little at a time, allowing slack to develop in the guy line. A sudden gust of wind snapped it. Anyone want to buy some small pieces of aluminum tubing?

But, I'm not licked yet. It's going up again and this time it's not coming down again.

I'm using quarter inch guy lines this time and the dead-man is being replacing with an automobile wheel, filled with cement (both sides) to which an iron pipe is securely welded and set in a hole about four feet deep.

Woolner's wheel. When this concrete filled automobile wheel is firmly buried, it makes a guy anchor which will not fail.

When this old world begins to shimmy and shake, I'm going to climb my tower, where I'll be safe.

. . . Ted Woolner WA1ABP

Ken W. Sessions, Jr. K6MVH
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Ontario, California

VHF Operation by Remote Control

Remote control operation for the radio amateur using 440 MHz as the control frequency and FM as the control mode.

Who needs it?

When you are mobiling along, trying to maintain an intelligible QSO, haven't you noticed how trees, ignition interference, and tall buildings seem to deliberately obscure the other fellow's most pertinent comments? How hills, obstructions, and QRM wipe out your pithiest responses? Haven't you wished your mobile could sport a 100-foot-high antenna? Or that your transmitter could match the power output of your home rig? It can.

You can drive around town carrying on QSO's with all the armchair-copy characteristics and "getoutability" of the home rig. How? With the seldom discussed but often used technique of remote control. Remote control is the transmitting *and receiving* through a QTH rig from a mobile or less-well-situated fixed station.

It is somewhat surprising that remote control is not in more common use on the ham bands, considering the ease with which it can be achieved and the many advantages it accords the user. A special permit is required for remote control, but this is certainly no obstacle. There are no exams or proficiency tests involved—only the assurance that your remotely controlled equipment won't go wild while you're not there to watch it. It is true, however, that the FCC does impose a few constraints on remote operation. The most important of these are:

- Input power cannot exceed 900 watts
- Control—but not necessarily operation itself-must be accomplished from a *fixed* station (though it can also be accomplished from a mobile)
- A licensed operator must monitor from the fixed control point while the remotely operated equipment is in use.

The last two conditions may appear as formidable barriers to remote operation, but such is not the case at all. If the XYL is licensed, for instance, she can serve as the monitor while you're mobile, even though you're performing all the control functions from your car. It's just that the primary control point (which, in this case, is where the XYL is monitoring from) must have the capability of overriding any control signals emanating from your mobile. This philosophy assures that the equipment can be turned off in emergencies even when the mobile is out of range.

Another convenient way of complying with the FCC restriction requiring a monitored control point is to set up your remote control system as a joint venture with a few of your friends who operate the same mode and band you do. This idea also offers obvious economic advantages because the cost of the remote control equipment can be mutually shared.

Remote control is ideally suited to group or club participation. One of the chief advantages—outside of cost-sharing—is that a group of participants means a group of locations from which to choose your remote site. (Naturally, you'll want to set up the remote equipment at the best physical location.) Another advantage in making a remote operation into a group project is that remotely operated equipment will be controllable from a number of fixed points, at least one of which should be available for monitoring while others are mobile.

For those who like to know facts or figures before committing themselves to reading a complete article, here they are: A complete remotely operated amateur radio system can be built up—using an existing station—for as

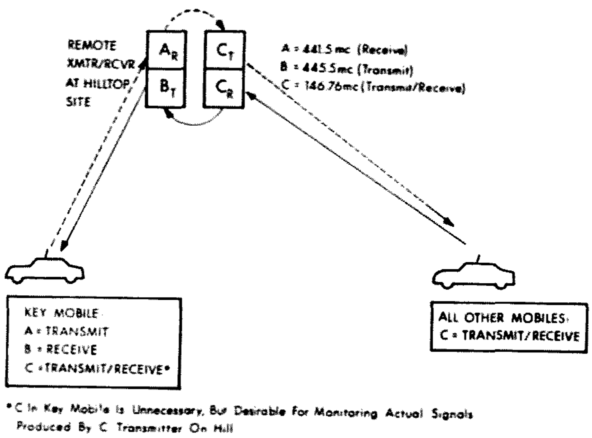

Fig. 1. Operation of repeater and remote base station.

little as \$200. Or it can cost as much as \$1000. It depends on such factors as how fat the junkbox is and the availability of radio-control transceivers—the prime expense.

Here's what remote operation involves:

The already established amateur radio station must be outfitted with a VHF (220 MHz or above) transceiver, which will serve as the control link. The transmitter portion of the control link transceiver will be set to operate on 6 or 8 MHz away from the receiver portion so that the receiver and transmitter can operate simultaneously. It is standard practice to operate the control link transmitter on the higher of the two frequencies.

Each mobile and fixed station wishing to communicate through the QTH rig (or "remote") is then equipped with similar units. But these, of course will be operating on opposing frequencies; that is, the receivers will be tuned to the control link's transmit frequency and the transmitters will be tuned to the control link's receiver channel.

Most remoters use FM for the control mode. FM gear is more readily available than AM and FM offers such advantages as superior noise rejection, greater sensitivity, excellent squelch characteristics, and better audio quality than AM.

Once the control link is established, the QTH rig is interconnected with it so that, on command from one of the control points, any signal received on the QTH receiver is coupled automatically to the control link transmitter, whose push-to-talk relay is keyed as long as the signal is there. The control link receiver (still operating even though the transmitter is keyed) is interconnected so that presence of any signal causes incoming control-link audio to be coupled to the remotely operated transmitter, whose push-to-talk relay is similarly keyed.

Remote operation is particularly well suited to VHF bands, where direct mobile-to-mobile operation is hampered by noise, distance, and physical location. In the Los Angeles area, there are more than 20 remote control stations in use on two and six meters. Some of these started as AM stations controlled on UHF FM, but virtually all have changed their mode of operation to FM. This shift to FM is due partly to the tremendous advantages of FM in the areas already noted, and partly to the nationwide trend toward amateur FM on the VHF bands.*

Typical frequencies (or channels) used across the nation for FM operation are 146.34, 146.70, 146.76, 146.82, and 146.94 MHz on two meters, and 52.525 MHz on six. There are also standard two-meter repeater frequencies on FM: the adopted input is 146.34 and the output is 146.94 MHz.

As noted earlier, there are no rules that compel remote operation on FM, but the

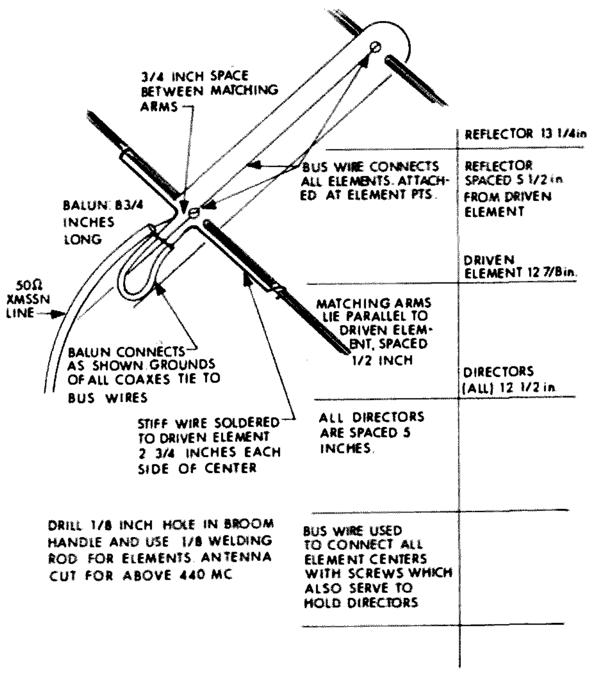

Fig. 2. Multielement yagi for control frequency.

*Marshall Lincoln W7DQS, FM Hams—The New Breed, Electronics Illustrated, July 1967.

inherent advantages make it very attractive. Important points to consider when making a decision: FM rigs are plentiful, inexpensive, and highly reliable; and muting of an FM remote during the no-signal state is extremely simple.

While the FCC requires remote control other than via wire line to be achieved from above 220 MHz, transceivers operating in the 220 MHz band are scarce and costly. FM units operating in the 450-470 MHz band, however, are not. And these units can be easily tuned to below 450 MHz. As a consequence, most amateur remote facilities are controlled in the region between 440 and 450 MHz.

Most cities – particularly the larger ones—have ambulance services, taxi companies, or municipalities with roomfuls of antiquated 450 MHz FM gear that no longer complies with FCC regulations governing commercial use, but which would be ideal for amateur service. Experience tends to prove that these units can be purchased for 35 - 50 dollars each when buying in lots of five or ten. They may run between 75 and 100 dollars if bought individually.

Fig. 1 shows how a remote system is employed. In the system pictured, the remote equipment operates on two meters FM. The control link receives on 441.5 MHz (called freq A) and transmits on 445.5 MHz (freq B). The dashed lines indicate signal flow from the key mobile (remoter), while the solid lines show the return circuit from other hams operating on the established frequency of the QTH rig, which in the case shown is 146.76 MHz (freq C).

Using but one control link, any number of frequencies may be selected for remote operation. My own equipment is capable of operating on 50.4 MHz (AM) and 146.76, 146.82, and 146.94 MHz (FM). Rig switching and channel changing is easily accomplished from the remote control point with simple control devices.

If you *really* want good results and maximum coverage during remote operation, locate the equipment on a hill or in a tall building. The U.S. Department of Agriculture, Forest Service, controls a large percentage of the acreage in mountainous regions. In 1965, the Forest Service adopted the policy of leasing land to amateurs for radio remote control applications. For an annual fee of $25, you can be assigned a good hilltop location (if there's one near you) and build your own shack there for radio gear to be used from a remote control point. Southern California is rich with such sites in the national forest reserves. At one site, near San Dimas, California, the government has turned over some 19 acres of prime hilltop land for amateur use. There, a small group of us pooled our limited resources and constructed a small brick building that satisfied the requirements of the Forest Service.

Using gear that we collectively donated, we installed a three-band amateur radio system and operate it as a joint venture. Since the hilltop is twenty miles or so from the nearest of us, we take turns troubleshooting when one of the remote transmitters malfunctions.

Remoting offers a number of fallout advantages over direct mobile and station operation. For six-meter hams, an obvious benefit is the absence or minimization of television interference. Another is the reduction of noise at the operating point. The FM gear you'll be using for control won't be susceptible to QRM from ignitions, power lines, and the like. And there will be no QSB as long as you're operating within good two-way range of the remote site. If you're 5 - 9 when you leave home, you'll be 5 - 9 at your destination—subject to normal fluctuations attributable to band conditions, of course.

Are you sold? All set to get some gear and start operating via remote control? All right! Send now for FCC Form 610 so that your license can be modified to include remoting. Then start looking around for:

- A good location
- Some buddies to share the expenses and fun
- A bunch of old 450 MHz taxi or police radios (If you have trouble locating them, drop me a line)

And while you're at it, why not consider operating on one of the NEW BREED FM channels on six or two?

Get your workshop in order and get ready to build.

Preparing the Equipment

When a discussion of remote operation comes up, there are always those who will use the terms "repeater" and "remote" interchangeably. To salty remoters, the two are completely different, though related, things. A repeater is operated in-band—

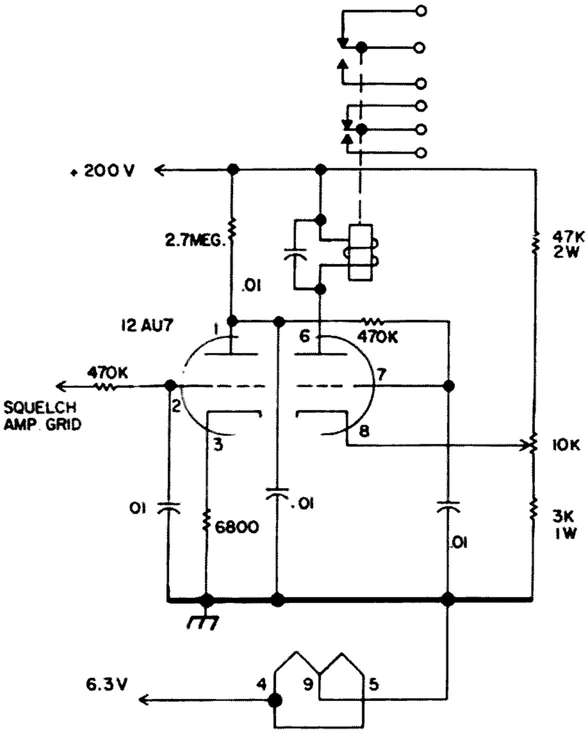

Fig. 3. Schematic diagram of carrier-operated relay.

that is, it retransmits whatever comes into a receiver tuned to an *adjacent* frequency in the same band. A remote is a fixed-frequency station (generally) which is operated and controlled from a completely different band. A remote installation usually involves a repeater on the control link frequency, and a repeater (except when wireline-controlled via a leased telephone pair) virtually always does.

To be entirely successful, the control link should itself be a complete and independently operable repeater. Using 450 MHz FM as the control link simplifies construction of the repeater portion of your remote station because the equipment is inexpensive, handbooks and circuits for the used commercial gear are readily available, and usually no special rf shielding is required.

The most commonly available makes of used 450 MHz FM gear are GE and Motorola, though occasionally one finds a "fleet" of such makes as DuMont (Fairchild), Kaar, Aerotron, or RCA. They're all relatively well known, but documentation for GE and Motorola is easiest to come by. Used mobile units sell for about one-half to one-third the price of a 115-volt unit (called a base station). So it is felicitous, if you're so inclined, to use a mobile unit for the base station by building up an ac supply.

A typical mobile transceiver, such as Motorola T44 or GE's Pre-Progress Line (or, in the jargon of remoters, simply Preprog) requires around 500 volts at 150 mA (minimum) for the final amplifier, 350 volts at 60 mA for the final multiplier, and 250 volts at 150 mA for the oscillator, multiplier, and receiver section. A negative bias voltage of around 25 volts is also required for the transmitter.

Tuning up these commercial FM units is a breeze. Each stage that requires tuning terminates at a test point designed to accept the prods of an ordinary VOM. GE Preprog units are the epitome of simplicity. Each test point is plainly marked and is positioned in the proximity of the adjustment point. Tuning of transmitter—and in many cases receiver—stages involves monitoring of the test point with a 0-3 volt dc meter and adjusting slug for maximum meter deflection.

The test points of Motorola T44's are pin jacks of a standard 11-pin socket, and are designed to be monitored with a 0-50 microampere meter.

This article will not go into such items as power supply construction or radio tuneup, as these are aspects which will vary according to the vintage and make of FM rig.

You'll find that, invariably, all commercial FM transmitters and receivers are crystal-

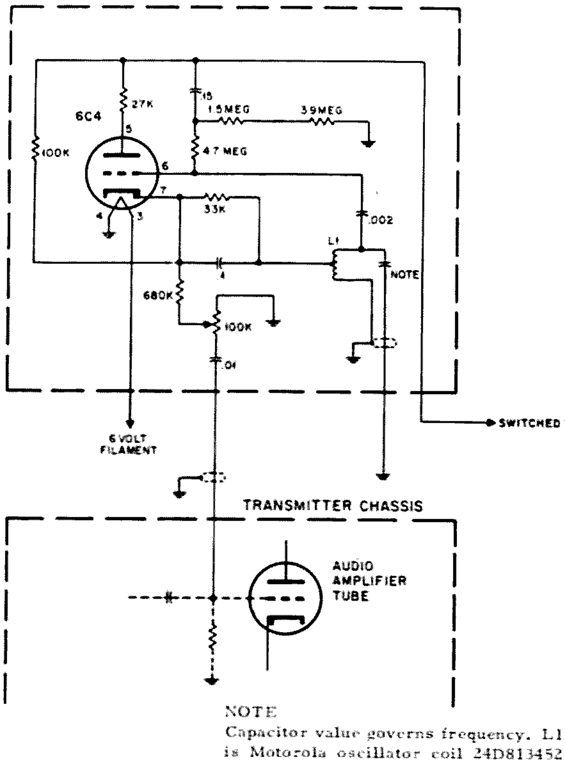

Fig. 4. Single tone oscillator.

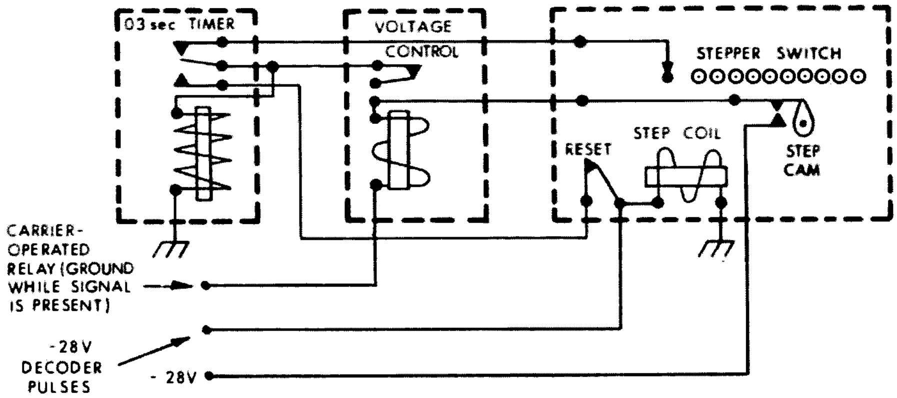

Fig. 5. How pulses from the decoder (not shown) can be used to drive the stepper.

controlled. Don't make the mistake of buying crystals for your transmitter before you are certain as to the fundamental frequency and know the circuit in which the crystal will be used. If you are in doubt, mail a copy of your oscillator circuits (any crude sketch is OK) to Sentry or International Crystals and mention the model number, manufacturer, and the approximate date of manufacture of the equipment you've got, as well as the desired operating frequencies for transmit and receive. They will grind the crystals for you and mail them COD. The International crystals will cost you a bit more than you'd have to pay if you bought them from another source, but you can be sure they will oscillate—and be dead on frequency at that. (A self-addressed stamped envelope to me will bring you prompt crystal frequency information on *any* Motorola or GE unit. This data has been prepared on a computer tab run and is available to all interested amateurs.)

The transmit frequencies should be judiciously selected so that no multiple of the oscillator frequency falls within pull-in range of any of the receivers (including *if's*). Without consideration of these factors, the emission of one of the transmitters can seriously desensitize the control link receiver.

GE units often come equipped with cavities, which help greatly to eliminate adjacent-channel interference. If the two control link frequencies are well spaced, however, you shouldn't need a cavity. Two antennas must be provided for the control link, too. These should be *vertically* separated as far from one another as possible.

Antennas are simple to construct for the 450 MHz region. An adequate groundplane can be built in 15 minutes by connecting 6-inch pieces of brass welding rod to a chassis-mounting RG-8/U connector. According to the mandate from the FCC, the control point must employ a directional antenna. **Fig. 2** shows how a simple yagi can be constructed from a broom handle and a few pieces of welding rod.

The next step is the one that turns the 450 MHz system into a repeater: construction of a circuit that senses presence of a received signal and keys the transmitter push-to-talk relays so that received audio is coupled automatically to the transmitters. Where the operating mode for the remote facility is to be FM, the switching function is easily achieved with a carrier-operated relay, which becomes an integral part of the receiver's squelch circuit.

Its principle of operation is simple: When no carrier is present, noise would ordinarily appear at the loudspeaker. A good FM receiver couples the higher-frequency components of this noise to a noise amplifier, the output of which is rectified and fed to a squelch amplifier which keeps the audio amplifier in a cutoff state as long as the noise is present. But when the noise disappears, indicating the presence of a carrier on the frequency, the audio ampli-

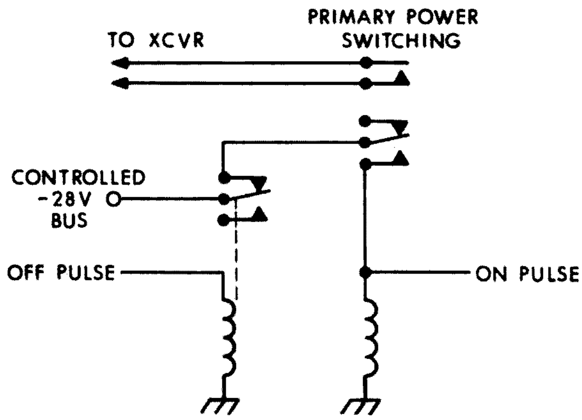

Fig. 6. Electrical latch relay for on/off function control.

fier comes on. A dc amplifier with a sensitive relay in series with the plate lead can be driven with the same signal supplied to the squelch amplifier, so that contact closure results from the presence of a legitimate audio signal. When the noise disappears, the contacts will of course immediately reopen. The schematic of the carrier-operated relay, **Fig. 3**, shows its simplicity and gives details on how it may be connected to any conventional FM receiver.

The mechanical relay portion of the circuit is a standard plate relay with a coil resistance of 8 - 10 K. The contacts energize the push-to-talk circuits and allow audio switching.

With a carrier-operated relay (on the control receiver) to operate the control link and remote transmitters, the repeater portion of the system is complete. It is also desirable, but by no means essential, to connect this type of relay to the remote receivers. Without it, the control link transmitter will be keyed continuously during remote operation, regardless of whether the remote operator is transmitting or receiving. This can be a little rough on finals. If you intend to operate this way, a blower on the 450 MHz final amplifiers is a must, whether you'll be running five watts or fifty.

Command and Control

The most important aspect of any remotely operated station is control. And the nucleus of a remote system is its command and control circuitry, or "brain."

Control is probably simplest using a tone system whereby control points (and mobiles, if desired) are equipped with fixed-frequency audio oscillators, called *encoders*, while the control link receiver at the remote site is provided with a simple frequency-to-dc converter, or *decoder*. The audio frequency to be used is immaterial so long as the encoder and decoder are matched. It might be wise to remember, however, that higher audio frequencies (2500 to 3000 Hz) are further removed from the voice range, so decoders on these frequencies are less susceptible to voice tripping.

The decoder does nothing more or less than provide relay contact closure when the proper tone appears at the control link receiver. But by connecting a stepper switch to the decoder, and using a conventional telephone dial to pulse the encoder, a minimum of ten discrete functions can be controlled—one for each digit of the dial.

Fig. 4 shows a schematic diagram of a common single-tone oscillator often used for control applications. The unit is easy to build and fits into a standard Minibox chassis. The output is high impedance and should be fed to the grid of the speech amplifier at the control point.

The decoder, somewhat more difficult to build than the encoder, is a small, commercially available unit that sells for $15 to $25 used. (If there is no source in your own area, decoders may be purchased by mail from Mann Communications, 18669 Ventura Blvd, Tarzana, California.) Robert Mueller (K6ASK) has designed a completely solid state encoder with matching decoder that is satisfactory for control.* His design is not as inherently stable as commercially produced units, but has proved adequate for this application.

Since the frequency of the encoder can be shifted anywhere within the usable audio spectrum by varying its key capacitor, this portion of the system may be constructed before you have decided on a decoder.

After the encoder and the decoder have been set to the same frequency, the encoder may be installed in the control point transmitter as shown in the schematic. The decoder should be installed in the control link receiver so that audio from the discriminator is coupled to the decoder input. The decoder output can then be connected to a standard stepper switch to provide the basis for the command portion of the brain. **Fig. 5** shows how pulses from the decoder (not illustrated) can be used to drive the stepper.

In the circuit shown, voltage is kept from the wiper arm of the stepper switch until the digit has been selected and the contracting arm has come to rest at that point. In addition, voltage is removed from the arm as a prerequisite to resetting the stepper to its zero (home) position. With this approach, the wiper arm only sees voltage when the stepper has been engaged, but never during the actual stepping process.

As soon as the wiper arm moves, the step cam contacts close to energize the 28-volt dc bus (relay control voltage). This 28-volt

*Coltin, L. (K6VBT), "Stable Tone Units for Remote Radio Control," FM Bulletin, January 1968, VDB Publishing Co., 2005H Hollywood, Grosse Pointe, Michigan 48236.

signal is prevented from getting to the function selector deck by the voltage control relay, whose contacts are held in by the ground signal from the carrier-operated relay. When the carrier drops, the ground signal disappears and the controlled voltage is applied to the function selector (wiper arm) where it must perform its control function within a very brief time span (0.3 second in the case shown). In summary, when the stepper has been properly pulsed (as with a tone pulse train from an encoder driven by a telephone dial), the operator drops carrier, and the voltage control relay opens to apply wiper voltage through the timer. At the end of the 0.3-second period, the timer pulls in to supply voltage to the stepper reset contacts. (These contacts pulse the stepper rapidly until the step cam contacts open, at home position.)

Using the momentary voltage pulses which appear on the selected contacts of the stepper to perform useful functions is a simple matter with latching relays. Five latching relays will control ten functions (five "on" and five "off"). **Fig 6** shows how an electrical latching relay can be built from two standard relays.

With the electrical latching relay, an "on" pulse from the stepper applies a brief voltage pulse to the coil of the primary power switching relay. The relay stays closed even though the pulse is removed because continuous coil voltage is applied through the made contacts of the "on" relay itself. The voltage is obtained through the normally closed contacts of the "off" relay. When power is removed or lost or when the "off" relay is pulsed, voltage is removed from the "on" relay and the function must be selected again with the stepper to reenable it.

Electrical latch relays provide the kind of fail-safe operation that pleases the FCC when its engineers consider an amateur's plans for a remote facility.

If there is a telephone at the remote site, a very useful and inexpensive mobile telephone system can be built into your control circuit. It would probably be a good idea to check with the local telephone company before making any connections. however.

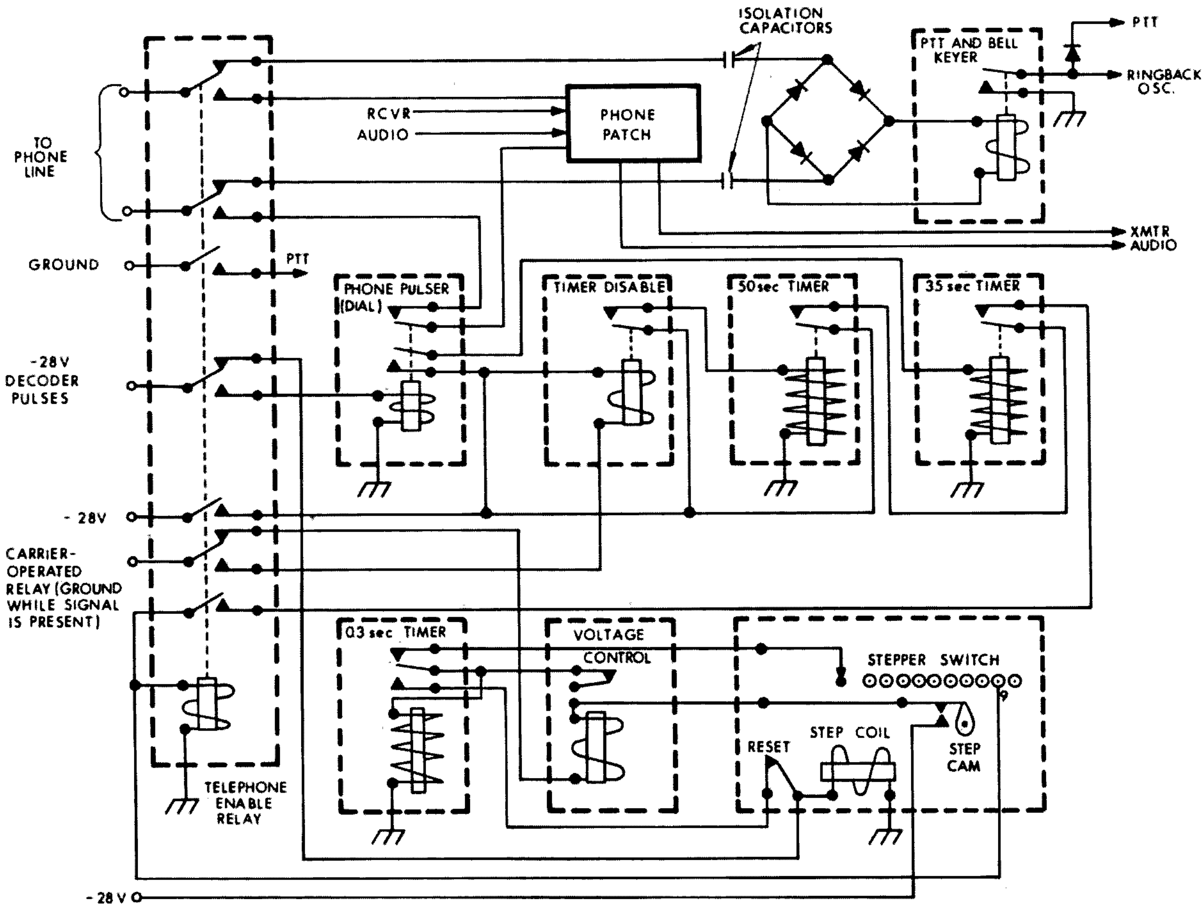

Fig. 7. Telephone circuit which can be incorporated into the control system with no modifications to the existing circuitry.

The telephone circuit of **Fig. 7** was designed by Fred Daniel, W6NQS. It can be incorporated into the control system with no modifications to existing circuitry. The beauty of it, aside from its simplicity, is its flexibility. Mobiles using the system can initiate calls or answer the telephone when it rings at the remote site; the telephone itself can be used to control shutdown functions if you want to use the stepper for ten "on" functions; and the installation will cost but one contact of the stepper.

The conventional telephone uses but two wires to accomplish what may amount to a multitude of functions. There is typically a low-voltage dc level across the lines to drive the carbon microphone element. When the telephone rings, however, a higher-voltage ac signal is superimposed on the lines to energize the bell.

The control circuit of **Fig. 7** takes advantage of these characteristics so that the line can be continuously monitored for incoming landline calls without disrupting the normal control functions of the remote radio installation. While the control portion of the system (lower three enclosed squares of the diagram) is in normal use, the phone lines are sensed for the presence of an ac voltage (indicating that the phone is ringing). The lines are fed through a set of normally closed contacts on the telephone enable relay to a bridge circuit. The dc component of the line should be isolated by placing a capacitor in series with each conductor of the telephone pair. A sensitive plate relay (with a coil resistance of 8 -10K ohms) on the output of the bridge rectifier pulls in when the phone rings and keys the push-to-talk of the control link transmitter for the duration of the ring. The momentary closure of the sensitive relay can also be used to trigger an oscillator or other signaling device so that when the transmitter is keyed by the phone, a ring signal is generated also.

The diode in the circuit keeps the ring-back oscillator from energizing each time an operator keys the push-to-talk. The diode, of course, must be reversed if polarity of the system is not as shown in the schematic. The system depicted here uses negative 28 volts because the power supply was doubling as a bias voltage source for several transmitters.

The ringer may be a simple relaxation oscillator such as the one shown in **Fig 8.** This may be constructed in a few minutes with a couple of capacitors, a resistor, and a neon lamp. The device shown delivers a varying pitch tone that is easily identifiable at the receiving end.

When the remote operator wants to place a call or respond to a phone ring, he dials a preselected number to energize the telephone enable relay (the digit 9 in the case shown). Here's what happens in the control portion of the system when a 9 is dialed:

The - 28V decoder pulses (one for each digital increment, or a total of 9) are fed to the stepper coil through a set of normally closed contacts on the telephone enable relay. With each pulse, the stepper moves one position. The step cam contacts of the stepper close when the stepper is first energized and do not open again until after reset has taken place.

It should be noted that some steppers do not have these step cam contacts. Their function can be simulated, however, if the stepper has an extra deck with its own wiper arm. The function is achieved by bussing all the contacts of the extra deck together and running a lead from this buss to the voltage control relay (where the step cam connects on the diagram). The wiper arm, forming the other contact of the make-shift switch, is connected to the 28-volt source.

When the stepper moves from its home position, a 28-volt potential is applied to the voltage control relay, whose contacts are pulled in as long as the dialing operation is taking place. (This is accomplished because the ground side of the relay coil is supplied from the carrier-operated relay.) After the 9 is dialed and the control-frequency carrier disappears, the voltage control relay drops out, applying voltage to the 0.3-second timer, which feeds the 28-volt signal to the stepper wiper through its own normally closed contacts. At the end of the 0.3-second period the timer pulls in, removing voltage from the wiper and applying it to the stepper coil reset contacts. When the stepper resets, the step cam again opens and control voltage is removed from the system.

The selection sequence described above completes but one function: It causes a 0.3-second, 28-volt signal to appear on the ninth contact of the stepper. That short signal causes the telephone enable relay to pull in and lock itself in the energized state. A constant voltage from the 28-volt buss is applied to one of the normally open contacts

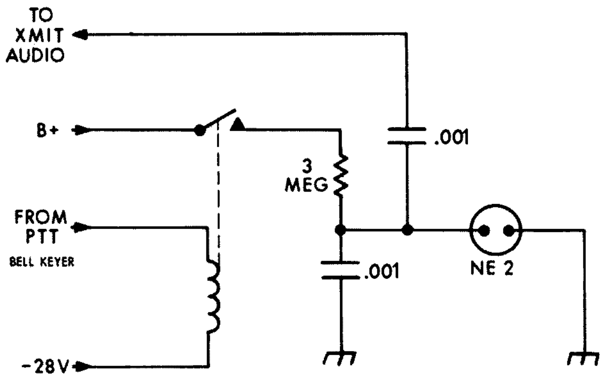

Fig. 8. Relaxation oscillator for effecting telephone ringback.

of the telephone enable relay. Thus, when the relay pulls in momentarily the buss voltage is transferred to the relay coil to hold it in. In this case, the voltage is passed through the normally closed contacts of two timers in the telephone circuit, both of which are used to remove coil voltage (and thereby accomplish telephone hang-up) under certain conditions.

With closure of the telephone enable relay, the phone lines are disconnected from the rectifier circuit and fed directly into the phone patch for audio mixing and transfer. The decoder is coupled to the phone pulser relay so that additional dialing will pulse the phone line rather than the stepper. The push-to-talk of the transmitter is keyed continuously. A ground signal from the carrier-operated relay is supplied to the timer disable relay as long as the remote receiver is receiving a signal.

After a telephone conversation has been completed, hang-up may be achieved in either of two ways: The operator may drop his carrier, causing the timer disable relay to close and supply coil voltage to the 50-second timer. At the end of its period, the timer opens to remove coil voltage from the telephone enable relay and return the control system to its normal state. As a quicker alternative, the operator might want to accomplish hang-up by transmitting a continuous tone. This causes a continuous 28-volt signal to appear on the coil of the phone pulser relay, holding it in so that a steady voltage is applied to the coil of the 5-second timer. When the timer pulls in, coil voltage is removed from the telephone enable relay. The phone is ready to accept other calls, and the stepper may then be used to select other functions.

The telephone lines can also be used for control of remote functions. It makes a very comfortable backup system for shutdown when a remote transmitter gets stuck on the air or the decoder blows a tube (or transistor). Soundness of overall design notwithstanding, such things *can* happen. For shutdown, simply connect a relay to the bell keyer (shown in upper right corner of schematic **Fig. 7.** A control-voltage signal on the relay can then be routed through individual diodes to as many latch relay "off" coils as desired.

If a stepper switch is connected to the bell keyer, each sequential ring can be used for control of a separate function. To discourage unwarranted control from "wrong numbers" and casual calls, the first seven or so contacts of the stepper should remain unused. In this way, control won't be initiated until the phone has rung at least that many times.

The control elements discussed in this article were *command* functions, as opposed to passive control measures. Passive control includes automatic logging of calls; automatic, timed station identification with a tape playback unit; automatic shutdown in the event of failure or loss of control; transmission-length limiting devices; and function-monitoring techniques. These will have to be discussed in another article. We're out of space.

. . . K6MVH

"I'm switching to short wave transmitting! That smoke is killing my sinus!"

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An Invisible Antenna

Since the beginning of radio communications, antennas have been constructed from metal conductors. These antennas have taken all forms from a single piece of random length wire to elaborate trapped yagi beams for multi-band operation. The handbooks are full of antenna designs to suit each individual need for an antenna to work on the desired frequencies.

The one thing all these antennas have in common is the need for some form of support. These supports also cover a wide range. They vary from a simple wooden "A" frame mast to self supporting 100' towers embedded in tons of concrete. They crank up and down, fold over in the middle, or are laboriously climbed by the young in heart and body. For the most part, they require miles of guy wires which are invariably tripped over by the neighborhood children and lead to law suits amounting to thousands of dollars in damages. A tower, in legal terms, is classed as an attractive nuisance. Where there is a tower, a child will feel compelled to climb it. He (or in the case of tom-boys, she) will invariably get hurt and the parents will take this opportunity to sue. There goes your life savings.

In addition to the above hazards, the apartment dweller or the ham with antenna restrictions from antiquated zoning laws is continually bemoaning his lot in life and is restricted to the use of antennas which are neither visible nor require a support of any kind.

These unfortunates go to all extremes to hide their ham activity. They fold dipoles in the attic; wrap miles of wire under the eaves of the house; have ingenius devices to erect the antenna after dark and collapse it during the daylight hours; and even pretend to be CBers. These poor souls live in fear that their neighbors will catch them at their hobby.

A solution has finally been reached. Why do we continue to construct these massive arrays? I suppose it is tradition. Like the guy who votes with a certain party because his grandpa and his pa did, so he does too. If it was good enough for them, it's good enough for him. Here we are in the space age with semiconductors replacing tubes, integrated circuits being used in place of racks of equipment, and we still stick with the age old metal element antennas!

It may come as something of a shock to most of you that the world of antennas does not begin and end with metal conductors. Ionized air makes a perfectly fine conductor, and can be used to construct a more than adequate antenna for all needs. It eliminates any need for a tower or other means of support. In reality it is a very simple process.

A rod, or column, of air may be ionized either by the use of radioactive materials, or by using an X-ray machine. In the first instance, an arrangement using radioactive materials set deep within the bore of a lead cylinder may be used. A pivot device at the base at ground level makes aiming of the antenna possible to give maximum gain in the desired direction.

Since radioactive materials have created a dumping problem for the agencies who are experimenting with them, it should only be a matter of a brief time before they become available on the surplus market.

The X-Ray method would be a bit more expensive, and considerably more complicated to execute. This requires extreme high voltage dc to be fed into the tube. It's target then emits a powerful stream of X-Rays to ionize a column of air. The target support can be of the same type as the one using the radioactive material, but would require more shielding and protection from the weather since the actual machine would be the source of the beam.

Since lead shielding is required in either case, I would suggest that you begin stocking up on this material before the demand becomes great and the price goes up. I would also suggest that if you have any tower sections lying around, you get rid of them in the near future before they become obsolete.

. . . WIEMV

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Using Your Electromagnetic Wave

A long, long time ago, a hairy hominid sat upon his haunches, and stared with a newly awakening interest at the campfire before his cave. He noted the smoke rising vertically over the African landscape, and then gently rippled the grey-black currents with his hands. A ragged puff was formed, an unusual, unnatural effect. Perhaps it would cause notice, he thought. Perhaps he could call Ur, over in the next valley.

Over the centuries, first our hominid and his friend, Ur, and then their descendants experimented with this novel means of communication, this way of extending their voices. They noted that the insertion of certain types of vegetation into the fire would provide a darker, and hence more visible, column of smoke. They discovered that the use of an animal skin in lieu of one's hands was much more efficient in forming the signal. They developed a code of sorts. And one day, our hominid's descendants were delighted to read the message from the other valley that almost had to say: "Ur sig 59 hr OM, name is Mu."

And then they went on to more important things.

They began to communicate with one another about the problems of their day. "Food here." "The men from the Serengeti are attacking the village." "Animals are near." "My daughter needs a husband."

They went on to more important things.

Thousands of years later, I, a radio amateur, sat at my desk in Dallas and communicated with a fellow named Peter in Pitea, Sweden. After a brief exchange of electromagnetic fields at the speed of light, I was possessed of the information that my signal had indeed reached Sweden in fairly readable form. He was little better informed than I. We did not go on to more important things.

It was a contest of course. Admittedly, but for the contest, he probably wouldn't have been on the air. But still! Zip! Forty-five seconds! What result? "5-7, name is Peter; 5-8, name is Don."

I became intrigued with this voice from beyond the sea, this man named Peter 5700 miles away. I discovered his QTH in the callbook, and dug out an old *National Geographic* map. There it was, Pitea, a small town near the arctic circle, on the Gulf of Bosnia. What sort of place was Pitea, I wondered. A port, no doubt. Was it also a manufacturing town? An agricultural center? What sort of climate would there be near a large gulf at that latitude?

But most of all, what of Pete? Did he have a family, a home? What were his interests, his ambitions? Was he Catholic, Protestant or Jew? Did he have other hobbies? Could he perhaps garden during the long days of summer? Do the long winter nights depress him?

How does he support himself, or his family? Is he a doctor, a sailor, a lawyer, a forester?

And of most interest, my little boy's question: "Has he ever seen a reindeer?" I wonder too.

And was he curious about that far off place called Dallas?

"5-7 in Sweden; 5-8 in Dallas, 73 old man."

Are we squandering a birthright?

Isn't it time we moved on to something more important?

We have the technical ability, and a political license, undreamed of during the long history of man on this planet. We have at our fingertips, and under our practical control, the only known constant in the universe, yet we persist in communicating an insipid jumble of numbers and names, briefly noted and quickly forgotten.

We should be entering a new age. We are, instead, squatting, not unlike that hairy predecessor of ours, and metronomically assuring ourselves, over and over, that the signal is getting out. Or we persist in describing our equipment, and the minutiae of our problems, and the airways choke with the endless stream of 811A's in grounded grid that seem to me to proceed through my

speaker to infinity and back. We are discussing the means, not the end.

I realize that a lot of my fellow amateurs enjoy contests. I respect their right to their opinion, even though it may strike me as sheer idiocy to spend eighteen to twenty hours exchanging numbers to obtain the immense privilege of having a call-sign printed in six point type among thousands of others. And I respect the desires of others to collect awards, although that activity seems more akin to stamp collecting than to a communications hobby or service, and has become ludicrous in many instances. "Work six eskimos for the Polar Bear Award! Special endorsement for SSB." Now really!

But, as I say, I respect my colleagues' right to enjoy their hobby in the way they see fit. No, I do not call for the abolition of contests or awards. Nor do I suggest that every DX contact become a ragchew. It is impossible in view of our numbers. But I worry, gentlemen. I worry about our image. I wonder about our casual disregard of our unlimited power to increase understanding on this troubled planet.

So how do we begin to extend ourselves, to move on to more important things. I would suggest two ways. The first is quite simple. The second requires a little work. As a starter, why not simply avoid the two most common subjects of conversation, the rig, and the weather, and substitute questions about the other man's family, his anticipation, his other hobbies or interests. The weather is, after all, transitory. And the description of the rig tells us nothing of the man, or his society.

Secondly, there is an indirect approach, the use of that forgotten document of courtesy, the QSL card. Here again, we send mostly numbers and abbreviations, and descriptions of the rig, and perhaps a short "tnx fer QSO." Instead, how about a Polaroid snapshot of our house, or our children, an interesting note, a question or two. Send a comment about anything *but* our rig and our signals. Tell them of our occupations, our thoughts, our plans. Tell them of your city or town, of how the mayor is elected, your opinion of miniskirts, the ecology of the surrounding countryside, the school system, the sports that are popular. Anything to *communicate!* To show people we are not all long haired hippies, or hate mongers. To show that we are a normal people, with the thoughts, dreams and ambitions of others, everywhere. And perhaps, they will respond in kind.

Expensive? A little. More trouble than expense, really. But try it with, say, every tenth DX contact and see what happens.

May I now respectfully bow toward the memory of The Old Man. May I bow also to all those wonderful old timers, (my father was one) who built our hobby with their endless and painstaking experimentation and gave us this control over a mysterious cosmic force. And a third, and final bow to those who by training and ability are able to continue this experimentation and research. I envy their minds, and their prowress.

But after those bows, may I suggest a turn to the future. To the future of unlimited world communication. To the extension of understanding throughout the world, perhaps as difficult a task as designing a transceiver. May I suggest a turn from outdated operating techniques, from the concept of a relay organization, from T.O.M.'s cat and the wouff hong, and those other antiquities.

Can we not feel a stirring within us like that of our hominid friend after he had established the reliability of his system. Can we see something more wonderful in the smoke? It can be used for so much more.

Perhaps even Mr. Maxim would agree. Perhaps he would, in 1968, transmit something that, freely translated, would say: "I don't give a damn about the signal report. What's new in Sweden this fine day?"

. . . WA5HPV

Dayton Hamvention

This is one of the big conventions of each year. Don't miss it. April 27, 1968 at the Wampler Arena Center, Dayton, Ohio, sponsored by the Dayton Amateur Radio Association. QSO in person at the nations foremost radio event of the year. There will be technical sessions, exhibits, hidden transmitter hunts, and an outstanding program for the wives. For further information write: Dayton Hamvention, Box 44, Dayton, Ohio 45401.

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ITV Got You Down?

Try these simple cures to beat it

Are you plagued with a peculiar "buzz saw" sound every 15 kHz on your receiver? From conversation with other hams I would guess that most of us on the low bands occasionally are. This "buzz saw", or ac modulated signal originates in the horizontal sweep circuit of television sets, and when not properly suppressed, can cause more QRM than a kilowatt next door. When your TV set is operating, an electron beam is flashed across the television screen from inside the picture tube at a rate of 15,750 sweeps per second, creating a harmonically rich 15.75 kHz ac modulated signal. This mess is then either carried over the ac power line, radiated from the TV antenna, or radiated through the back of the television set's cabinet. In accordance with F.C.C. part 15 regulations, manufacturers are supposed to suppress this signal, but often because of cost cutting, very little suppression is actually accomplished. So, as in electrical interference and TVI, the responsibility for curing this is left to the radio amateurs. How do you cure it? This article was written to show you how. There are several suppression steps which can be taken, each progressively more drastic in nature. Depending on how far away the offending television receiver is, you may have to take any number of suppression steps.

Line radiation

The first and most common means of radiation of the horizontal sweep circuit signal is through the power lines. To suppress this, the best method is to bypass the line cord with capacitors. Take two .01 mfd. disk ceramic capacitors with a rating of at least 150 volts each, and solder them between each side of the ac line and the television set chassis at the point of entry or interlock. This should cure at least some of the interference, and if the set is several houses away from your rig, this may provide all of the suppression that you need. In both of the TV sets suppressed by WA7BGO and me, the bypassing had already been done by the manufacturer of the sets. However, if yours is an older model, this probably has not yet been done. If you are still receiving the 'buzz saw" signal after this step, read further.

TV antenna radiation

As with the ac line, stray coupling may exist between the horizontal sweep circuit and the television antenna system. To cure this, a high pass filter should be installed. There is no need to buy one. Just write to the manufacturer of the offending television receiver explaining the problem, and they will gladly furnish you with a brand new Drake filter absolutely free of charge. When you connect the filter, be sure to install it inside the television cabinet to minimize radiation. With this you are killing two birds with one stone; minimizing ITV and TVI. If this step does not completely wipe out the harmonics, the next "block buster" step is guaranteed to cure the most severe cases of ITV.

Direct radiation from the horizontal sweep circuits

Radiation may escape through the television cabinet and be radiated quite a distance. The obvious solution is to shield the cabinet. I taped sheets of aluminum foil to the inside of the TV cabinet until it was almost completely shielded (there were some inaccessable spots). Then in several places the shielding was grounded to the chassis of the set. Radiation out of the front of the set is almost nil as TV picture tubes are coated on the back with a metalic paint that effectively shields the front of the set.

You May Have A Deduction Coming On Taxes

If you operate MARS, that is. Read on, tnx to WB6AEO who pointed this out in the Internal Revenue Bulletin for 23 October 1967:

"Unreimbursed out-of-pocket expenses incurred by the taxpayer, a civilian "ham" operator, in operating his radio equipment as a volunteer member of the supplemental program of the Military Affiliate Radio System (MARS), an organization of military radio stations and facilities established at United States Army and Air Force installations, are contributions or gifts within the meaning of section 170(c) (1) of the Internal Revenue Code of 1954 and are deductible subject to the limitations set forth in section 170(b) (1) (B) of the code."

Further, ". . . a deduction shall be allowed for any charitable contribution . . . subject to certain limitations." And ". . . the Code defines "charitable contribution" as including a contribution or gift to or for the use of a State, a Territory, a possession of the United States, or any political subdivision of any of the foregoing, or the United States or the District of Columbia, but only if the contribution or gift is made for exclusively public purposes." And ". . . no deduction is allowable for a contribution of services. However, unreimbursed expenditures made incident to the rendition of services to an organization contributions to which are deductible may constitute a deductible contribution." And the kicker: ". . . the nonreimbursed out-of-pocket expenses incurred by the taxpayer for the operation, maintenance, and repair of his radio equipment which are directly attributable to the performance of such voluntary services are deductible. No deduction is allowed for . . . a proportionate share of the general maintenance or repair . . . or for the fair rental value . . . or for the depreciation occasioned by such use . . ."

So there you have it, lads. It appears to the Editor (though the IRS may not agree) that this same reasoning would apply to expenses incurred in any PUBLIC SERVICE type of operation such as AREC, RACES, etc.

Reprinted from The Footprint, the bulletin of the Foothill Amateur Radio Society, Palo Alto, California, edited by Jim Lomasney WA6NIL.

After the taping of the aluminum foil to the inside of my family's small portable, and a large cabinet type at WA7BGO's house, we were unable to find any trace of the buzz saw signal on either of our station's receivers.

The only real difficulty encountered was trying to convince my parents that the TV was radiating illegally and that I had to tear into it. A call to the local FCC office revealed that a standard FCC letter will be sent out on request, explaining ITV and the FCC's position to the TV owner, should any difficulty with the owner arise.

In conclusion, this project has been most enlightening in the area of ITV and has improved communications at WA7BGO and WA7CSK tremendously.

. . . WA7CSK

(*Ed. note*: *Use caution with foil shielding as complete blocking of air circulation leads to excessive heat and may ruin a transformer or other component*).

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The YF Fights Back

Most husbands, I've been led to believe, are considerate enough, but that OM of mine most certainly never was! He turned into one of those Ham "Monsters" and began to forget to kiss me when he came home from work. He never asked me how my day went, or how the children were. He would just rush in the door, and make a bee-line for that trash-pile he calls a radio shack. He would lock all his doors, throw a bunch of switches, and fill his ears with wild, nerve wracking screetches.

I remember one particular day when he came home and followed the above procedure. I had dinner ready, and it was all set to put on the table, so I sat down and began to figure a way to get him to come out to eat. Just for laughs, I thought I would try calling him for a change.

"Dinner's ready, Darling" I casually sang. I cocked my ears to hear through all the QRM in the shack, and presently the locks moved and the door swung open. To my utter amazement, the OM burst forth.

"Have you seen my soldering gun?" he asked innocently. Looking past me, he spotted the gun on the chair by the table. He darted forward, snatched the iron, and disappeared back into his hole before I could protest.

"Your dinner is getting cold, Baby Doll", I called sweetly. He answered by turning up the receiver gain full blast. I began to get a little shook.

"K6–!, here is your XYL calling and sitting by!" I stuck my ear to the door to see if he copied.

"Sorry, OM," he was saying politely, "Little QRM on you that time. Better give me that again."

A trifle irritated at this point, I went into the kitchen and returned with a hammer. Being a little familiar with the code, I very lightly tapped out "CHOW" on the shack door, splintering the panel. I listened.

"Can't copy, OM . . . some lid is sending CW on ur frequency."

Still undaunted, I retreated to reorganize my attack. Deciding on a new offense, I grabbed the scissors from the sewing machine drawer, and zipped out the back door. His transmission line was no problem at all for my pinking shears and it gave easily after two snips. Smiling coyly at my genius, I raced back into the house to see my results. After hiding the shears, I waited at the dining room table. He would be sauntering out in no time, I calculated. I waited a few minutes, but still no sign of the beast from 50 million cycles. I snuck up next to his door again, and put my ear to the keyhole.

"I was in QSO with a guy down on forty a few minutes ago," he was saying, "but the band folded suddenly, so here I am on six.

To heck with dinner. I got myself a ticket and now have a rig sitting where the dining room table used to be. Once in a while I have a QSO with the OM. He's not such a bad guy once you get to know him. He does have his faults, though. It seems he always wants dinner when the skip is in.

. . . WA6SPT

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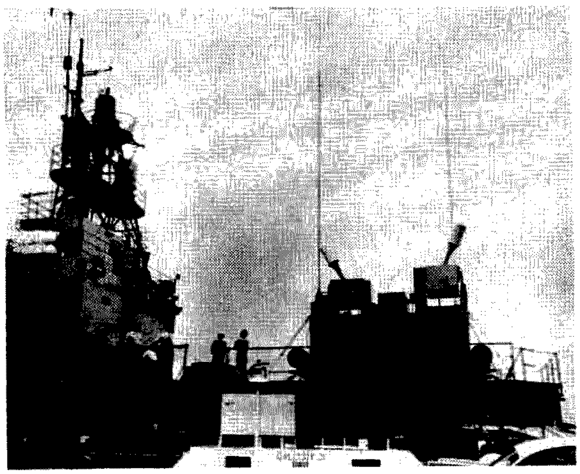
A Career in Electronic Engineering

If electronics has captured your interest long enough for you to get a ham ticket, you have probably thought about Electronic Engineering as a career. If so you have undoubtedly run into a lot of contradictory information. On one hand you read about the major layoff's in the "Aerospace" industries, a decline in the enrollment at engineering colleges, and government statements about the "surplus" of engineers. On the other hand, the current Los Angeles Times Sunday edition—which is a barometer of the engineering profession—is bulging with help wanted ads for Electronics Engineers. Many of the trade magazines carry editorials on the shortage of skilled engineers.

Which story is correct? Is there a demand for engineers? If so, is the demand here to stay? How do I prepare for a career in Electronics Engineering? Will I find it challenging and financially rewarding? These are some of the questions you have probably asked yourself.

Currently there are about 260,000 graduate engineers of all types active in the aerospace and electronic industries. About 90% of these entered the profession since World War II. A majority of these are veterans who went through school on the GI bill. The World war II group (which has set outstanding scholastic and engineering records) is now in the 40 to 50 year bracket. They are entering middle management and corporate executive positions. The Korean war group is at the Senior Engineer and Project Manager level. This leaves a shortage of engineers in the 1-10 year experience level. This shortage is becoming more acute because of a decline in engineering enrollment.

The shortage of engineers with rf backgrounds is even more critical. For the past decade the educational emphasis has been on digital computers and digital techniques. Suddenly, industry is realizing that there are very few qualified rf engineers. The required shift of all telemetry activity from the 215-260 MHz band to the 2.2-2.3 GHz band by 1970 has precipitated a crisis in many programs. Challenging programs like the POLARIS S-band conversion and POSEIDON are seriously short of engineers with experience in all phases of rf design, and no doubt will remain so for many years. The satellite communications system (both commercial and military), and commercial television also need rf engineers. If you enjoy working with rf the future is very bright.



A wide range of engineering skills went into this portable telemetry station. This system recovers telemetry data from POLARIS missiles and has facilities for tracking the missile and destroying it if it goes off course.

Educational Requirements

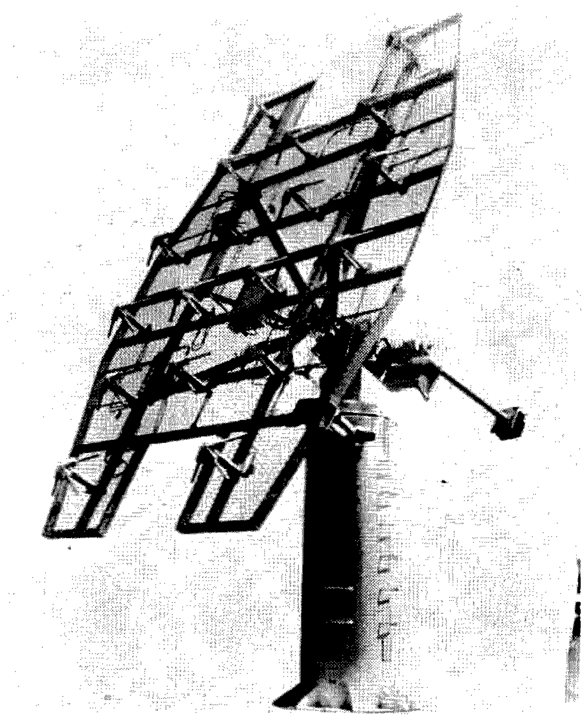
Before World War II an ambitious self educated man could crack the engineering profession. Now the table stakes are much higher. It requires a minimum of a Bachelor of Science degree with the Master of Science degree becoming increasingly important. In fact, some colleges report that as much as 30% of their graduating students go directly into graduate study.

With this trend to graduate education we can logically expect that in 10 years the average engineer without a Masters de-

gree will find his opportunities severely limited. Even now a high percentage of employment advertisments read "Engineer wanted MS preferred". This means that to provide yourself with the best training and background to maximize your career opportunities you should plan on five years of college. This is expensive, but don't get discouraged. Where there is a will there is a way—in fact, several, ways.

Earlier I mentioned that the majority of Engineers were veterans. Most of us realize that to maintain our free society every citizen has a responsibility to serve in our armed forces. By careful planning you can receive valuable training that may be used for college credit, and qualify for the GI bill which will pay for your formal education when you get out. All of the services have good electronic schools. However, the Navy schools seem to have the edge on technical excellence. Many service courses are accepted for lower division credit at engineering colleges. It is advisable to discuss your plans with a counselor at the college of your choice prior to enlisting.

There are numerous other sources of financial aid available to the engineering student. These range from scholarships, outright grants, federal student loans to work aid programs at the colleges. Your best help in locating funding is your local public librarian. Also check the scholarship section of the college catalogs and talk to your teachers.



This Canoga TELTRAC system automatically tracks missiles with telemetry signals in the 215-265 MHz band. It was used to track the project GEMINI capsule. Systems of this nature require skills in the rf and servomechanisms fields.

Types of Engineering Schools

There are two basic approaches to engineering education in the United States. If you are certain that you are interested in Electronics, the Polytechnic college may be your best bet. Schools like California State Polytechnic College start right off with electronics courses in the freshman year. The conventional schools concentrate the general courses in the freshman and sophomore years and the electronics courses in the junior and senior years. Get catalogs from several schools of each type and compare the curriculum before deciding.

Compensation

Will engineering pay a good salary? The February 1967 graduating class averaged about $668 per month in starting salaries. The average for Southern California research and development oriented companies was about $734. You can reasonably expect to double your starting salary in 10 to 12 years.

As with any career, salary is only part of the compensation, and not the most important! Engineering can be as exciting as you want to make it.

. . . . W6JTT

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What is YOUR "Amateur Q"?

Listen to the various bands and what do you hear? You hear "authorities" of all degrees and kind on any subject that you might suggest; you hear some very interesting technical talk; you hear amateurs giving of their time and talent to the handling of overseas' phone patches for our servicemen; you hear some boasting of DX worked, high efficiencies of linear amplifiers, very high forward gain and front-to-back ratios for beams, etc., ad infinitum. Unfortunately there is also a lot of idle chatter that does not fall within the Amateur Code and much operational procedure that does not fall within the FCC RULES AND REGULATIONS, PART 97, AMATURE RADIO SERVICE. Let me quote from SUBPART A, General, 97.1, Basis and Purpose," . . . an amateur service having a fundamental purpose expressed in the following principles:

a. Recognition and enhancement of the value of the amateur service to the public as a voluntary non-commercial communication service, particularly with respect to providing emergency communications.

b. Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

c. Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in both the communication and technical phases of the art.

d. Expansion of the existing reservoir within the amateur service of trained operators, technicians and electronics experts.

e. Continuation and extension of the amateur's unique ability to enhance international good will."

THIS IS OUR CHARTER FOR EXISTENCE! How do you think WE as amateurs accomplish what is intended in the above listed principles! I'm not sure, AND I'm not going to judge the amateur fraternity as a whole on the basis of the actions of a few. What's more, although I have very definite interests within the scope of the enjoyment of amateur radio, I feel that each amateur has the right, within the laws, to pursue those interests which provide him the most enjoyment and satisfaction, such as CW, SSB, AM, VHF, TRAFFIC, etc.

What I would like to do in this article is to provide some thought provoking material which I hope will in some small way improve amateur radio and at the same time make us more respectful of the liabilities which we accept when we obtain a license from the FCC.

How many of us have an up-to-date copy of the FCC Rules and Regulations, Volume VI (October 1966), in which PART 97-Amateur Radio Service, is included? I'll bet a good percentage have never seen one? I'll also bet that most are using the appendix to the License Handbook, and, an old edition at that. There have been changes in the laws under which we operate over the past few years, not very large changes but changes which affect us. On what do you rely for the latest information on changes in the laws? How can you comply if you are not knowledgeable about the laws?

I had these thoughts in mind recently as I was reading PART 97 when an old tried, true and familiar equation came to mind—"Q = X / R"; one with which we should all associate the word *MERIT*. I would like to use this equation, but with a slightly different interpretation, to establish not a figure of merit for an inductor based upon the relationship of its reactance to its resistance, but an AMATEUR Q (amateur figure of merit) based upon the relationship of our compliance (or positive reactance) with the laws to our resistance (or non-compliance) to the laws. Therefore, my equation reads as follows:

$$Q = \frac{X}{R} = \text{Amateur "Q"} = \frac{\text{Compliance with the laws}}{\text{Resistance to the laws}}$$

Where

Compliance means "being knowledgeable about the laws and making an honest effort to comply with them".

Resistance means "not knowing the laws and making little or no effort to comply with those which require a small degree of difficulty or time consuming energy".

Now that I have defined the terms in my equation, how will we use this equation? SUBPARTS C, D, and E, Chapter 97, Volume VI, FCC Rules and Regulations contain the laws pertaining to "Technical Standards", "Operating Requirements and Procedures" and "Prohibited Practices and Administrative Sanctions" respectively. Each paragraph in these SUBPARTS details laws governing our operation of an amateur station. Later in the article I have posed some questions on each paragraph which should stimulate some thought about how well we *comply with* or *resist* the laws. In order to develop some numbers which can be inserted in my interpretation of the figure of merit equation, I have arbitrarily assigned a point value of "10" to each paragraph since I was not able to "weight" each in terms of its importance (each is a part of the total law). Below I have provided a "Q-Card" for you to tally the evaluation of your "compliance" and "resistance". Columns "X" and "R" are provided for these tallies respectively. Now, after you have read the question(s) for each paragraph, analyze your operations in terms of "compliance" and "resistance", and then assign values to "X" and "R", being mindful of the fact that the sum of the X and R values must equal 10. For example, if you feel that you fully comply with the law, then you would enter 10 under X and O under R; 70% compliance would result in entries of 7 under X and 3 under R; complete failure to comply would be entered as O under X and 10 under R.

SOOoooo—now proceed to the questions—do some soul-searching—BE HONEST AND FORTH-RIGHT! You won't be kidding anyone but yourself if you don't sit back and really think about your operations in terms of the law.

"Q-CARD"

Paragraph	Point Value	Amateur Q "X"	"R"
97.61	10		
97.63	10		
97.65	10		
97.67	10		
97.69	10		
97.71	10		
97.73	10		
97.75	10		
97.77	10		
97.79	10		
97.87	10		
97.97	10		
97.99	10		
97.103	10		
97.105	10		
97.111	10		
97.113	10		
97.115	10		
97.117	10		
97.119	10		
97.121	10		
97.123	10		
97.125	10		
97.129	10		

FCC Rules and Regulations Subpart C: Technical Standards

97.61: Authorized Frequencies and Types of Emission.

a. Are you familiar with the limitations, both frequency and type of emission, in the band, and/or bands, in which you operate?

b. Have you gone outside the band to work on elusive DX station?

97.63: Individual Frequency Not Assigned.

a. Since you are not assigned a given frequency, how gentlemanly are you when someone "zeros-in" in on the frequency you are using?

b. How well do you avoid "Net frequencies", particularly those whose mission accomplishes a really worthwhile purpose such as the "Eye Bank Net", and many, many others?

97.65: Special Emission Limitations.

a. How do you determine the bandwidth of your signals for the various types of emission that you might use?

b. Is your test equipment adequate for the purpose?

97.67: Maximum Authorized Power.

a. Maximum DC power input to the final amplifier stage of an oscillator-amplifier transmitter or to the plate circuit of an oscillator transmitter is one kilowatt (1 KW). This paragraph also states that input power in excess of 900 watts must be accurately measured. Can you comply with this requirement with your present transmitter? Remember that Power is the product of Voltage and Current!

b. The term "accurately" is used in connection with this measurement of DC Power. Do you know the accuracy of your meters, shunts and multipliers used to measure your power?

e. If you operate on those bands where the power limitations are much lower, how do you measure the power?

97.69: Radio Teleprinter Transmissions.

a. How do you determine that your speed is 60 ±5 words per minute?

b. For F1 emission the deviation in frequency from mark to space, or vice versa, shall be less than 900 cycles per second (hertz). How do you measure this?

c. For A2 and/or F2 emission, the highest modulating frequency shall not exceed 3000 cycles per second (hertz) and the deviation between the mark and space signals, or vice versa, shall be less than 900 cycles per second (hertz). What equipment do you have that will insure this?

97.71: Transmitter Power Supply.

a. What methods have you employed to insure that the ripple voltage from your power supply is not modulating your signal? Can you measure it?

97.73: Purity and Stability of Emissions.

a. How do you determine 100% modulation of an A2 or an A3 emission?

b. How do you determine that your SSB transmitter is delivering a "clean signal"?

c. How do you determine that you have spurious radiations, such as harmonics, subharmonics, spurious modulation products, key clicks, parasitic oscillations, and/or other transient effects?

d. How do you respond to a fellow amateur who tells you that you have a poor signal (or some problem)? Do you try to convince him that his receiver is no good or do you try to find out what the trouble is and make some checks with him?

e. Do you have a dummy load for testing purposes?

97.75: Frequency Measurement and Regular Check.

a. How do you determine the output frequency of your transmitter?

b. Can you check the frequency calibration of your receiver?

c. Do you feel that the accuracy designed and built into the equipment by the manufacturer is satisfactory for this requirement?

d. How long since you have checked your "100 KC Calibrator" against a standard frequency transmission from the National Bureau of Standards (or some other known standard of frequency of comparable accuracy)?

Subpart D: Operating Requirements and Procedures

97.77: Practices to be observed by ALL Licensees.

a. Each amateur station shall be operated in accordance with good engineering and good amateur practice. How good is your engineering practice? Do you have test equipment with which to measure or at least "monitor" your construction or installation work?

b. How well do you practice the "Amateur Code"?

97.79: Who may operate an Amateur Station?

a. The licensee of an amateur station may allow a non-amateur to speak over a microphone or to operate a teleprinter as long as the amateur turns the carrier on and off and signs the station off after communication with each station has been completed. Do you allow a non-amateur friend to speak into a microphone that operates a VOX circuit?

b. Does your teleprinter keyboard turn the transmitter on and off? If so, your friend should not operate the teleprinter according to the law.

c. Do you let Novices or Technicians operate your station?

97.87: Transmission of Call Signs.

a. Do you identify your station at the beginning and end of each single transmission?

b. Or, at the beginning and end of a series of transmissions, each transmission of which is less than three minutes?

c. And, at least once every ten minutes, or as soon thereafter as possible, during a series of transmission between stations having established communications?

d. And, at least once every ten minutes during any single transmission of more than ten minutes duration? NOTE: You should read this paragraph in the Regulations in its entirety; it's amazing, informative and interesting.

97.97: Notice of Operation Away From Authorized Location.

a. If you intend to operate "portable" for a period of more than 48 hours, do you provide proper notification to the Commission? (Portable in excess of 48 hours means that you do not return to your fixed transmitter location before 48 hours have elapsed.)

b. When you have moved, have you filed notice of "Portable Operation"?

97.99: Special Requirements for Nonportable Stations.

a. Have you applied for a modified license within four months of your move to a new home?

97.103: Station Log Requirements.

a. Do your logs include:

1. Date and time of each transmission.
2. Signatures of licensed operators who have operated your station.
3. Signatures of non-licensed persons who speak over your station.
4. Call sign of station called.
5. Time of signing off with a given station.
6. Input power.
7. Frequency band used.
8. Type of emission.
9. Location of station, particularly when mobile.
10. Message traffic handled.

97.105: Retention of logs.

a. Logs must be retained for one year from the date of last entry. Do you have your last log, if the date of the last entry is less than a year ago?

Subpart E: Prohibited Practices and Administrative Sanctions

97.111: No Remuneration for Use of Station.

a. Have you accepted material compensation, direct or indirect, paid or promised, for the use of your station? (Curiously: I wonder how "donating" to a DX-pedition, or accepting donations by a DX-peditioner, is evaluated in terms of the Law?)

97.113: Broadcasting Prohibited.

a. Broadcasting is defined as the dissemination of radio communications intended to be received by the public directly or by the intermediary of relay stations, or the retransmissions by automatic means of programs or signals emanating from any class of station other than amateur? Are you guilty?

97.115: Music Prohibited.

a. Have you transmitted music over your station, either directly or possibly from the background?

97.117: Codes and Ciphers.

a. Have you used any form of coding or ciphering, other than commonly used abbreviations?

97.119: Obscenity, Indecency, Profanity.

a. Has the speech in your transmissions been "clean and pure" even though disturbed by poor operating practice on the part of another?

97.121: False Signals.

a. Have you used the call letters of a station not licensed to yourself?

97.123: Unidentified Communications.

a. Have you properly identified your transmissions?

97.125: Interference.

a. Have you wilfully or maliciously caused interference to any radio communication or signal? (Like tuning up on the fellow whose operating practices you don't appreciate.)

97.129: Fraudulent Licenses.

a. Have you taken the examination for a license for another, or vice versa, has someone taken the examination for you?

b. Have you been diligent in giving examinations to applicants for Novice Class Licenses?

Now that you have read all the questions and are satisfied with your assignment of points, add up columns "X" and "R" and substitute them in the following equation.:

$$\text{Amateur Q} = \frac{X}{R} = \text{———} =$$

HOW DID YOU RATE YOURSELF AS A LAW ABIDING AMATEUR? Well, since I arbitrarily assigned the value of 10 points to each paragraph, and, you honestly (?) evaluated yourself—well—who really cares? We all should! It is our image, our public image, that will determine our future. For example, recent publicity resulting from newspaper, radio and TV coverage of the "mean ham" tarnished our image very much, even though at the same time there were many, many amateurs who were living by the Amateur Code and within the Basis and Purpose outlined in Paragraph 97.1. Anyhow, how does your "Q" stack up with the following:

Q	REMARKS
0- 3.0	You're licensed?
3.1- 5.5	Try harder!
5.6-10.0	You're GOOD!
10.1-25.0	EXCELLENT!
25.1-114	I said "BE HONEST"!
∞	You MUST be KIDDING!

If I haven't done anything more than make you more cognizant of the laws which regulate our wonderful hobby then my efforts will not have been in vain. I would recommend that you spend $1.25 for a subscription to VOLUME VI of the FCC Rules and Regulations, which covers PARTS 95, Citizens Radio Service, 97, Amateur Raddio Service, and 99, Disaster Communications Service. It is available from the Superintendent of Documents, Government Printing Office, Washington, D. C., 20402. You will then be able to have the law in front of you and will not have to rely on some "joker" whose "Q" is above 239,—scored of, by and for himself.

. . . K3STU

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

Earl Spencer K4FQU
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Ft. Myers, Florida 33901

And They Called "Mother Shipton" Crazy.

Are you a predictor of fantastic things to come? Do people point fingers at you and giggle behind your back? Well pay them no mind because what you predict has a 90 to 1 chance of coming true just as it did for Mother Shipton: and they almost hung her for a witch.

Some five hundred and ten years ago in the mid fourteen hundreds, when electronics was just a flash in the sky and every one believed the world was flat, "Mother Shipton", an old English witch, or fortune teller, made a startling prophecy that was ridiculed as the product of a crazy mind, but which has gradually been fulfilled through the passing centuries, all that is except one item described in the last two lines, which is still in the hands of the Almighty. He hasn't yet confided to any mortal whether it will come to pass in the next twelve months or not, even though the stargazers forcast dreadful events in store for us in the next year.

"Mother Shipton's" prophecy has been handed down, so it is claimed, just as it was originally written, and if that is so it is certainly a most remarkable document to read in these days of electrical and electronic marvels. Here it is;

Carriages without horses shall go,
  And accidents fill the world with woe.
Around the world thoughts shall fly
  In the twinkling of an eye.
Waters shall more wonders do.
  Things now strange shall yet be true.
The world upside down shall be,
  and gold be found at the foot of a tree.
Through hills man shall ride,
  And no horse or ass be at his side.
Under water man shall walk,
  Shall ride, shall sleep, shall talk.
In the air men shall be seen,
  In white, in black, in green.
Iron in the water shall float
  As easy as a wooden boat;
Gold shall be found and shown,
  In a land that's not now known.
Fire and water shall wonder do,
  England shall at last admit a Jew.
The world to an end shall come
  In eighteen hundred and eighty-one.

This ode copied from the January 1, 1928 issue of *Telegraph and Telephone Age*.

. . . K4FQU

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Recovering "Lost" QSLs

Have you ever wondered where all those QSL's are that the guys said they sent but you never received? Undoubtedly many of us at one time or another forgot to send the QSL we promised for one reason or another, but for those that were actually sent and not received read on.

Let me explain how you and your club might rescue some of those hundreds of QSL cards that are misaddressed, unforwardable or otherwise unable to be delivered by the U.S. Post Office each year.

Typically, those hundreds of QSL cards we just discussed are sent to the "Dead Letter Office" and are burned! What you say, first class mail being burned and not returned? Yes, that is right. Here in California the "the dead letter office" is in San Francisco. Can you imagine all those QSL's from that last state for W.A.S. on six meters, the rare one on 20 SSB, the Saudi Arabia station on 80 meters the gang didn't believe, all going up in smoke? Kinda hard to take isn't it. Well thats the way it is. To quote a few verses from the U.S. Postal Manual,[1] " . . . other mail including first class and Air bearing no return address is sent to a dead letter office or branch for final disposition." What determines if it is "Dead Mail"? Well, dead mail is defined as ". . . matter deposited in the mail which is or becomes undeliverable and which cannot be returned to the sender. First class is forwarded on fixed schedule to dead letter post branches from local offices", additionally, "dead mail that cannot be delivered to the addressee or sender is destroyed or sold".

Now that the problem has been pointed out, I think we can begin to offer solutions for saving those valuable QSL's. The most logical beginning is the sender of those lost cards. How does he send the QSL more informatively? As a start, address the card to WC6AAA, J. H. Ham. In bolder terms, include WC6AAA's name. This is quite important as J. H. Ham may have moved and WC6AAA may not mean a thing to the local postman.

In order to expedite mail, the Post Office has instituted many programs including ABCD, VIM, ZIP, NIMS, and POMSIP. Most of these resemble the CW abbreviations we use however mean less to you and I as amateurs. Of importance here though is the ZIP code we are fairly familiar with. As much as possible, use the other fellows zip code number in the addressing of his QSL. This helps the post office handle your mail more readily. Admittedly many of our fraternity do not even know their own zip code number and it would help considerably if they contacted their local post office found out what it is and included it in their return address.

If you are inaccurate in the town's spelling or even street spelling, you suffer no great handicap. The ZIP code is somewhat forgiving. It gives the area of the U.S. (including Alaska and Hawaii), the sectional centers and individual streets in the town. If you have money to burn, a "National Zip Code Directory", POD publication #65 is available through the Superintendent of Documents[2] for seven dollars. It lists all Zip numbers for all of the continental U.S. plus Puerto Rico, Alaska and Hawaii.

While speaking about addresses, be sure your return address is on the same side of the card as the stamp. This is also particularily applicable for club bulletins mailings. To quote a few more verses,[3] " . . . only postal and post cards that bear the senders address and request for return are returned . ." also "The return address of the sender must be shown on the *address* side of the mail to secure its return." and finally, " . . . on post and postal cards, second, third and fourth class mail of no

[1] *U.S. Postal Manual, POD* 11, *Parts* 158.5, 158.7, 158.72.

[2] ZIP Code Directory DOD #65, c/o Supt. of Documents, U.S. Gov't. Printing Office, Washington, D.C. 20402.

obvious value, the sender must place RETURN REQUESTED below the return address." Another thing too, don't waste money on needless postage, the Post Office does not recover any of these monies but rather the U.S. Treasury, so you can't improve the P.O. with donations.

The final mail (QSL) solution is now presented and it is essentially the most important. This is a workable and proven solution. If you are a member of a local radio club you have a major point in your favor. This step should be taken on your club's behalf and in their name preferably. For maximum coverage it would be a good idea to bring this up to your club.

To begin with, dress in your suit or sports outfit and approach your local postmaster. Call in advance to the post office you plan to visit, find out what the postmasters name is and arrange for an appointment with him (or her). When you show up to see the postmaster, have a couple of foreign DX QSL's and maybe a local one along with one of yours to show the postmaster. Explain to him that you are an amateur radio operator, a member of Podunk Valley Radio Club and local Civil Defense unit performing public services and would like to help him in his attempt to deliver some of those undeliverable QSL's he receives periodically. Tell him some of these cards might belong to a fellow club member or someone who a member of the club knows. Impress on him that those cards are valuable to the one whom they were directed, but useless to anyone else, (a stack of your own QSL's goes good right here to show the postmaster that amateurs collect QSL's as others collect stamps, butterflies, etc.).

Since this is your first encounter with the postmaster be reassuring to him. Explain that unless the cards are in some way delivered they would be set for a plight of incineration and lost forever.

Arrange to drop by the post office periodically to see if any cards have come in. Usually the postmaster will be happy just to get rid of them and pleased to see that he is doing some good by giving them to you. Normally these cards are held in General Delivery awaiting someone to claim them. Now that you have succeeded in obtaining those undeliverable cards, make it a point to try to forward them to whoever they belong, by looking up their call in the callbook, etc.

Congratulations! You have just prospered in selling amateur radio to your own postmaster.

This program can be put into effect on a nationwide scale by you and also your radio club. Many of those lost QSL's can be showing up on a regular basis but it requires your help.

As a last comment, the future of our mailable QSL's includes possible airmail stamps of magnetic ink to quickly distinguish airmail from all other classes of mail and optical scanners for sorting mail, reading the mail (ZIP codes) bundling it and even tying the mail bags!

. . . K6UMV

[3] et. al parts 158.21, 158.3, 158.3A.

PLEASE INCLUDE YOUR ZIP CODE WHEN YOU WRITE 73.

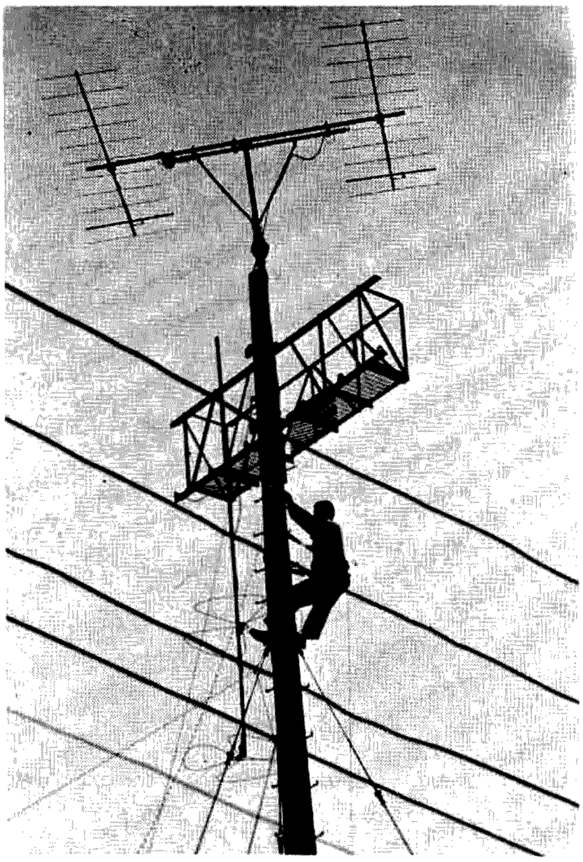
Project MOONRAY

NASTAR, the amateur radio group involved in research for outer space transmissions, has been encouraged to file a proposal for a ham transponder to be taken to the moon. Present indications are that there will be room for the package, dubbed MOONRAY, on the third LEM flight.

Since MOONRAY is an amateur project, the people at NASTAR want to get the opinion and advice of the amateur fraternity before finalizing plans for technical details of the project.

MOONRAY will be an isotope-powered package which will serve as:

1. A backup communications package for the Astronauts,
2. A site-relocation beacon to operate from the LEM landing site for one year or longer,
3. As an Amateur transponder.

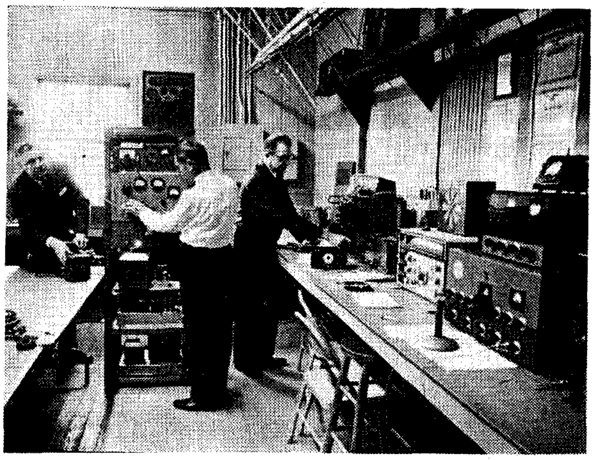


Bob Fratello, WA2UBO works at the 70 ft. level on the pole holding two meter Oscar antenna and stacked 2 Meter big wheels for QST work below.

Here are some of the basic technical requirements for MOONRAY:

1. Size and weight of the complete package must not exceed five pounds and 250 cubic inches (of which 100 cubic inches and three pounds has already been allocated to the powersupply, leaving 150 cu. inches and two pounds for the electronics, antennas, etc.)
2. It must operate throughout the entire lunar months at ambient temperatures ranging from minus 250° F to plus 250° F.
3. 432 MHz has been tentatively chosen as the operating frequency since this appears to be the best compromise as far as antennas, gain vs. size, free-space losses, power requirements, Transistor noise figures and efficiencies; and a frequency where hams can still home-brew equipment with relative ease at reasonable cost.
4. MOONRAY must not interfere with or affect any of the other experiments aboard LEM.
5. Reliability, ruggedness, environmental survivability and proven performance will have to be demonstrated and satisfy NASA's Lunar experiment standards.
6. The design concepts must be such that the package can be installed on the moon by our astronauts, simply, rapidly, and with minimum effort.
7. The unit must be able to function by earth-command as a site relocation beacon for later flights.
8. The transponder must also be usable as an easy-to-operate emergency communications link for the astronauts.
9. MOONRAY must have a command shutoff and turn-on capability in addition to an overrideable one year automatic shutoff timer.

For design purposes we have available 5 watts of electrical power, and approximately 200 watts of thermal heating power. Bear in mind that the size and power limitations imposed on the Lunar package must be met with minimum complexity and must have simple plug in operation compatible with the space-suit microphone/earphone and push to talk.



VHF room with staff at work.

In order to reach a final decision, and to finalize MOONRAY specifications, we need opinions, suggestions, answers and data on the following questions:

A. What mode of operation should we use? Should it be similar to OSCAR III with all types of transmissions, or a narrow band single-frequency for CW only? Other type?

B. What operating band should we use? Should it be 432 MHz transmit and 442 MHz receive? 2 Meter transmit and 432 receive with lunar transmitter on 432 MHz? 1296 MHz transmit and 1350 receive? Any other combination of the above, or?

Antennas

Since the operating bands chosen will determine the type, size, shape, etc., of the antenna system which will be used, the method of packaging, storage, handling and unfurling will have to be considered after parameters (such as operating modes and frequencies) have been decided.

Rather than duplicating the techniques used by OSCARS 3 and 4, we hope that new design concepts submitted for MOONRAY will demonstrate a substantial advance in the state of the art. You can help design and build MOONRAY from anywhere in the world by:

1. Offering solid, technically sound suggestions on the design questions.
2. Offering to design, develop and/or construct any part of the MOONRAY hardware to the specifications decided on as a result of your suggestions.
3. Passing along the above information to fellow hams, or any other technical people, who might help get MOONRAY on the moon.

NASTAR president, Nick Marshall at the board during a design session on the Lunar MOONRAY (Moon Amateur Relay).

Although LEM 1 is not scheduled for Moon -launch until 1970, we do not have too much time left. We must first get a firm proposal to NASA, technically sound enough to win their approval. Once approved, the first breadboard version of the design must be built and made operational. After any anomalies have been eliminated, the unit must be rigorously tested, section by section. Next the first flight model of MOONRAY is built and subjected to complete electrical and environmental tests. Then, finally, the actual package for the LEM flight can be assembled, tested, and turned over to NASA. Keep in mind that a second, "back-up" package will have to be built at the same time as the final unit. As you can see from this series of steps, 1970 looms almost too close for a project of this scope. Serious consideration of the questions above, *and prompt answers from you* are the first steps essential to getting MOONRAY on the lunar surface with LEM III. ■

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ASSB

"An alert southern California experimenter has added another remarkable discovery to the long list of technical advances originally achieved in the field of amateur radio"

This is not an article concerning the operation or technical theory of amateur radio Teletype communication. The ultimate purpose of this paper will not be to advance in anyway the current developments in this field. However, since this article had its beginnings in the construction of a simple AFSK oscillator, a discussion of this simple circuit must precede our description of this new technical advancement.

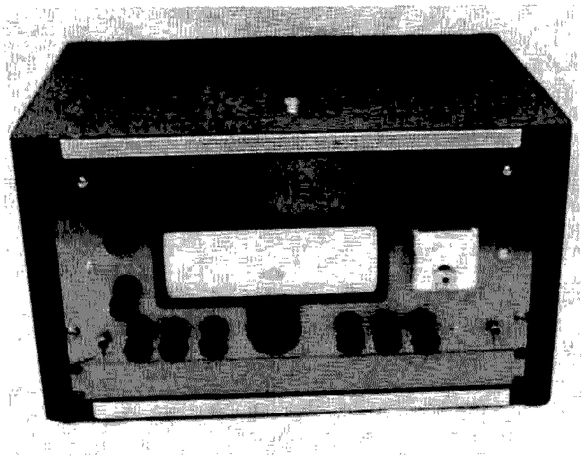
Having recently obtained a model 19 Teletype machine from the local MARS group, a W2PAT converter was soon constructed and the machine was providing excellent trouble-free operation just like the book said. Many enjoyable evenings were spent watching copy from commercial transmitters as well as twenty meter FSK and two meter AFSK. It soon became apparent that two meters had considerably more to offer than the HF bands, mostly because of the QRM on twenty and UPI was always in Spanish. After an inquiry directed to one of these AFSK operators on VHF, I soon was occupied in the construction of a simple one transistor AFSK oscillator guaranteed by all AFSK men to be the best there is. This project was completed in one morning and put into operation.

The oscillator was connected to the station transmitter directly into the microphone jack. The station receiver was used to monitor the AFSK signal from the transmitter. After connecting all the cables from the machine which was really the hardest part, the complete assembly was soon put into operation. After about three hours of "TME KUIKC BROEN FOZ KUMPED OVERA LAZY DOG%S BAAK MMM 123&56889" it soon became apparent that the printer was only giving 43.5 percent copy.

Not wishing to revert to any more experimentation, it was decided that the analytical approach was the best recourse. Being an adept engineer, the approach is obvious. For the reader unexperienced in the field of calculus, the following theoretical development may appear a bit bizarre, but let me assure you that it will be just as clear to you as to the veteran engineer or physicist. The first step is to note the inherent speed of the machine, 368 OPM, and to select a differential element of time in the basic 22 millisecond pulse duration and let this differential time element tend to zero with the pulse voltage peaks. Any engineer will tell you that this is the basic approach in differential calculus analysis. To make a long story short, we simply integrate the obtained expression over the percentage of machine copy from zero to 43.5 percent. Much to my surprise this resulted in a perfect representation of a Fourier series. Equation one shows this classical result, which is the only relation that need concern the reader.

$$f(t) = \sum_{n=0}^{\infty} a_n \cos nwt + \sum_{n=1}^{\infty} b_n \sin wt \quad (1)$$

Readers familiar with this formula will have



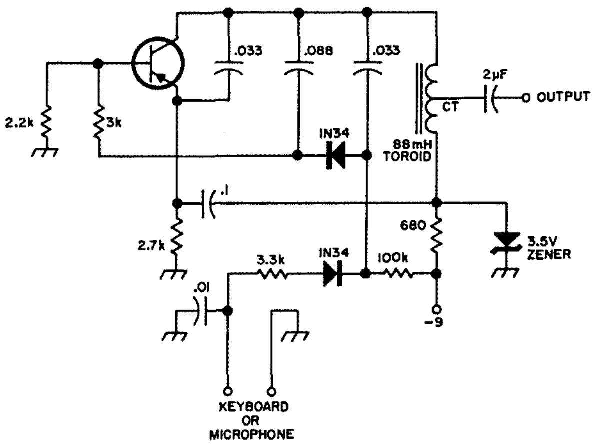
no trouble identifying the elements, and readers not familiar with its implications probably do not care, but a handy reference is given. (1) Stated simply, a Fourier series is used to represent a periodic function, and in this case, since the function is odd, the indicated series is the sine wave series. The following explanation is probably not necessary for the alert reader, but a glance at the schematic of the oscillator circuit, figure one, will soon show that the change in frequency of the oscillator is proportional to the change in resistance of the keyboard contacts. In my case since the contacts were not very clean, the change in resistance was not completely from infinity to zero. The application of a carbon microphone across the keyboard terminals on the oscillator will provide the necessary variation in resistance, and reference to the Fourier series, the proper signal to apply is the sine wave. Further experimentation showed that the applied signal could be any type of waveform, so the natural reaction was to talk into the microphone. All the rest is now history.

For the readers who have missed this development in the recent newspapers and scientific journals, the following recounting of the applications and advantages of this new mode of communications is included. This new method will be of particular interest to readers of 73 and other magazines who continually assault these magazines with their tirades on the idiocy or superiority of SSB or AM operators. There have been many problems in the development of amateur radio, but none have been so severe a threat to our organization and cooperation among ourselves as the continuous squabbling among our ranks over the use of these two modes. The unity of our fraternity has never been so close to becoming complete anarchy. The new discovery that I advocate will completely re-unite the veteran AM operators and those fools who still seem to think that SSB will someday develop into an acceptable mode of communications.

If you consider how my device produces a varying frequency audio signal corresponding to the resistance of the microphone, and how this signal is elevated above the zero audio frequency reference by the mark or space audio frequency of the AFSK oscillator, you will see that a corresponding single sideband signal with reference to audio is generated. Because of obvious reasons this new revolutionary mode will be called audio single sideband, or ASSB. The obvious advantages will allow an AM-only operator to use a mode comparable to SSB by simply plugging this unit into his microphone jack. This signal will be immediately compatible with SSB because any SSB operator will, upon hearing this Micky-Mouse sounding signal, immediately conclude that it is SSB, and a pleasant and enjoyable QSO will follow, free from the arguments and differences that have for so long made these two modes incompatible. Thus, we have a simple device that will allow any AM operator to go SSB while still retaining his AM gear, and most of his money.

In the future I expect to see much expanded use of this new mode, and it is for this reason, the unity and growth of amateur radio, that I have unselfishly decided to share my discovery with the rest of my ham brothers to whom I owe so much for the many years of enjoyable diversion that I have received in this hobby. But there is still one last unsolved problem that is still plaguing me. Does anyone know where I can find a schematic for a good AFSK oscillator?

. . . K6ICU



(1) Fitzgerald, A. E., *Basic Electrical Engineering*. 1967 by McGraw-Hill, Inc. page 141.

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Installing a Transceiver in a Hired Car

The antenna

Nowadays it is sometimes more convenient to fly to a place rather than drive your own car there. Then you can hire a car at the destination. Installing a rig in a hired car presents a number of problems, and it is proposed to discuss these problems in the following article.

One of the first problems is installing an antenna. This must usually be done without drilling holes in the car.

There would seem to be three basic possibilities:

1. The bumper mount. This is probably the easiest but also the most inefficient.
2. There is a clamp available for mounting on the trunk lid, using the small gap between the lid and the bodywork.
3. The roof rack method.

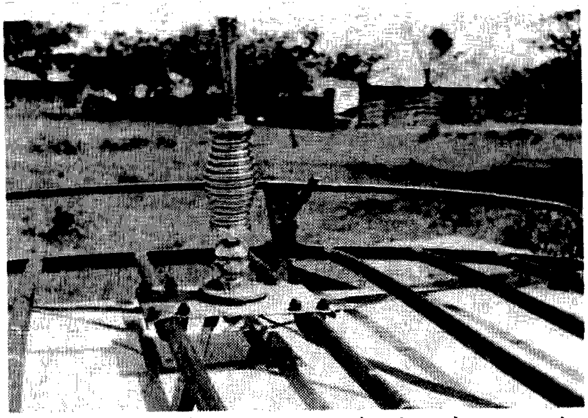
No. 1 was rejected owing to the inefficiency of bumper mounted antennas. No. 2 was tried, but this depends on the gap between trunk lid and body work being about right and also on the trunk lid not having a flange. No. 3 was the method chosen because of the inefficiency of No. 1 and the fact that No. 2 did not fit the car hired.

If a car can be hired with a roof rack, then a steel plate can be made and suitably drilled to take the antenna base. This plate can be mounted between the bars of the roof rack with U bolts.

This system has the advantage of high efficiency but only if a very good low resistance joint can be made between the outer braid of coax feed line and the main body of the car. One should not rely on the contact between the roof rack and the roof of the car. This may well be painted or otherwise it will probably become corroded.

In my case I decided to connect the bolts which held the antenna base to the steel plate. These were also connected to the outer braid of the coaxial cable-direct to the car roof with four copper braid connections at the four corners. I was lucky to find four tapped holes designed to take a different type of roof rack. In any case I did not rely on one copper braid but used four separate connections to our different parts of the roof.

In addition, the trunk lid was bonded by copper braid to the body of the car as was the hood lid, the engine and the tail of the exhaust pipe. Thus the outer braid of the coax feedline was solidly connected to the main metal of the car with a low resistance joint and was able to develop its full radiating possibilities without undue resistance losses.



Where the car has a roof rack, the plate can be mounted between the bars of the roof rack with U bolts. Copper braid connects the bolts to the four corners of the roof.

Where possible an ohmmeter[1,2] capable of reading down to fractions of an ohm should be used to check the resistance from the chassis of the transceiver to any part of the car and this should read less the 0.2 ohm to any part of the car.

To facilitate such an installation in the future, a pre-drilled steel plate to take the antenna base could be carried fitted with some adjustable arms and U bolts to cope with the different spacing between different types of roof racks.

1. Such a meter is manufactured by Evershed & Vignoles, called the Megger MB3

2. See article "How good is your mobile installation," *Mobile News*, December 1966.

In fact the installation described worked very well from Gambia where QSOs were made from the mobile installation to all parts of the world.

Suppression

While it is, of course, true that suppression problems are individual to each car, and can unfortunately only be solved by cut and dry methods, nevertheless certain basic principles apply.

In dealing with a hired car two considerations predominate:

A. No modification can be undertaken to which the owner would object.

B. You are obviously not prepared to spend the time and money which you would spend on your own car, as you will probably only be using the hired car for a relatively short time.

This means that the logical approach is to begin with those items of suppression which are most easily and cheaply accomplished and give the most tangible results. The greater refinements can be left until later and possibly omitted completely if it is not considered worth the effort or expense for the improvement produced.

Surprisingly enough, the first thing to check is the car clock. Some cars are fitted with electric clocks which are electrically very noisy on the high-frequency bands. If it cannot be suppressed easily, it is well worth trying to persuade the owner to have the clock disconnected during the period you hire the car. A noisy clock can cause you serious interference even when stationary and with the engine switched off. Therefore, the first essential is to put this right. All the other interference will disappear when the car is stationary. You can at least operate when parked, even if you have done no suppression at all, **provided** You have cured the clock noise. The best way is to disconnect it with the owner's approval.

Next, check the engine. Many cars will already have been suppressed to some extent. The quickest and easiest way is to fit suppressor resistors at the plugs (it is better to fit suppressed plugs if such are available and you are prepared to spend the money). Then fit one more suppressor resistance in the centre lead of the distributor. Remember there is a spark between the rotor and the distributor contacts as well as in the spark-

ing plugs themselves. This one additional resistor is often forgotten and makes a big difference.

Next put a feed through capacitor in the main dynamo (generator) lead, or equivalent in the main feed to the battery if an alternator is fitted. Lastly, do some bonding. Of course, you must bond the engine to the chassis or body. Remember the engine is mounted on rubber supports and may be well insulated from the rest of the car. Then the hood lid must be bonded to the body. This lid usually rests on asbestos tape which is quite a good insulator, so the only electrical contact with the rest of the car is through the hinges. These are either lubricated with a good insulating oil or they are rusty; so, unless you bond carefully, you leave the lid over the engine nicely insulated to act as an antenna to radiate engine noise to your own antenna.

This bonding of the lid has already been mentioned before in connection with the antenna mounting and general bonding, as has the bonding of the trunk lid and most important, the bonding of the tail of the exhaust pipe to the body. The exhaust pipe can be a beautiful radiator on 20 or 15 meters in a smaller car since it is about ¼λ long.

At this stage you should have achieved a considerable improvement. Note the regulator has not been tested. Clearly, this can be treated as described in many mobile handbooks and should certainly be done on your own car, but it was felt a break should be made here in hired cars to distinguish, Stage I, what might be regarded as essential, and Stage II, if the hirer feels inclined to devote more time and money to suppressing his hired car.

But at this stage a worthwhile improvement should have been achieved. With a hired Peugeot, sufficient suppression was achieved at this stage to make QSOs on 20-meters possible in motion, though on 15-meters only good strong signals could be copied.

In Stage II a series of further improvements can be suggested, such as—

1. Suppressing the regulator. You can listen to see if this is necessary.
2. Bonding all the sections of the exhaust pipe together. In Stage I only the tail was bonded to the body. But, in fact, all sections and the muffler should be

bonded together as they make bad electrical connections and ignition noise will probably not be fully suppressed until the whole exhaust pipe, mufflers, etc. are carefully bonded together. Here again a good ohmmeter reading really low voltages (such as the Megger MB3 described earlier) is very valuable. On testing one car where a good bonding braid was clearly visible between the tail pipe and the car chassis, a resistance of 2500 ohms was measured. This was not lowered until the whole joint was taken down, cleaned and reassembled and preferably greased with electrolube grease.

3. The accessories may need suppression such as windscreen wipers, petrol pumps, etc. but again this can be left to Stage II.
4. Wheel static and all the other refinements can be considered also.

On a hired car for a short period of use, however, enough may well have been achieved to make reasonably satisfactory mobile operation possible.

. . . G3BID

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Preventive Maintenance

No matter whether you are a DX operator, traffic man or just an average ham looking around for that elusive 50th state, you will recognize the situation. Just as you find the frequency that rare DX is listening on—or get ready to send that important message—or start to answer that W7's CQ . . . The lights flicker, the transmitter fuse pops, the rig goes stone dead and, for the moment, is just about as much value to you as a wad of used chewing gum. If it hasn't happened to you, it's only because you haven't been in ham radio very long. The situation is best described by Murphy's Third Law: "Things always pick the worst time to go wrong."

But it is possible to at least partially remove yourself from the clutches of blind fate. A little pre-planning will reduce the probability of being struck down by Murphy's Third Law. Here's how.

Almost without exception, hams wait until a component or piece of equipment fails before they perform any maintenance. This has two distinct disadvantages. One is that the equipment will fail at a time you are using it. The other is that the failure of one component will sometimes cause the premature failure of a second component.

However, it is possible to anticipate component failure and to minimize unexpected trouble. This can be done by making periodic checks, to insure that the equipment is functioning properly, and that no tubes or other components are on the verge of failure. This type of maintenance has been employed by commercial electronic users and the military for many years, and is commonly called Preventive Maintenance, or simply PM.

A system of PM for the ham shack can be as simple or elaborate as the operator desires. The purpose of this article is to give the reader food for thought, so he can decide for himself what degree of PM he wants to use in his own station.

First, take a careful look at the physical appearance of your equipment. Is it dusty and dirty? Are the knobs loose on the shafts? Do you sometimes have to whack the side of the cabinet to make that sticking relay drop out? Hams often learn to live with little faults rather than go to the trouble of repairing them. A good viewpoint to take when checking over the equipment is that it is someone else's equipment which you are considering buying. Then, all these little deficiencies will stand out like sore thumbs.

After you have the appearance up to snuff, the next thing to do is to check the tubes. After all, they are the most common cause of ham equipment failures. It is a good habit to replace the tubes from the sockets where they were, and not switch tubes of the same type. In a few critical cases, such as VHF converters or balanced modulators, switching tubes may require some circuit readjustment.

Now turn the equipment on, again checking it as if you were planning to buy it. Check for dirty switch contacts, noisy audio controls, intermittents, sticking relays, loose cables and connectors, dial slippage, etc. Then after a general inspection, it's time to check out the operation on all frequency bands and all operating modes—especially those you seldom use. When you have made these checks to determine if the equipment is operating properly, it's time to get into more detailed checks.

The receiver is a good place to start. There are various checks and tests which may be performed on the station receiver. Some of these require equipment which most hams don't have access to, but on the other hand, it is possible to make a great many rough checks with a minimum test equipment. If you can get it, a simple signal generator with calibrated output amplitude can be used to check the sensitivity of the receiver. If not, then perhaps you can arrange with another local ham to set up your receivers side by side, tune in a weak signal, and switch the same antenna back and forth between the two receivers. This will give you an indication if the sensitivity is grossly out of order. If you are a weak-

signal specialist (DXer or VHFer), you should have equipment on hand to check the noise figure of your converter or receiver. If you use a T-R switch, you should check to make sure the noise figure of the T-R switch isn't severely degrading the performance of your receiver. This can be done by switching the antenna from the receiver input direct over to the T-R switch, to see if there is a noticeable difference in weak-signal performance.

The dial calibration of the receiver should also be checked. If you have a crystal calibrator, this is the place to start, making sure it is still zero-beat with WWV, or a broadcast station. Then check with the calibrator to see that the dial accuracy of the receiver is OK—on all bands, and at both end of each band. While checking the frequency calibration of the receiver, it is a good idea to check the long-term and short-term frequency stability of the receiver. This may be done by tuning either to a crystal calibrator checkpoint, or a BC station and checking the frequency drift over a short and a long period. Also, the warm-up drift from a cold start can be checked.

There are many other checks which can be made on the receiver, such as the centering of the BFO in the receiver *if* passband, proper Q-multiplier operation, crystal filter alignment, etc. Again, check the receiver as carefully as if you were planning to buy it, and test everything you can think of.

The dial calibration and stability of the transmitter can be checked with the same methods used in checking the receiver. The audio quality and keying quality of the transmitter should also be checked. This is best done with the aid of an oscilloscope, but even without test equipment, you can check this by tuning the transmitter in on the station receiver and listening with a pair of earphones while someone else keys or speaks into the mike. Be sure and have some means for reducing either the transmitter output, the receiver gain, or both, so you won't overload the receiver input.

If you have an SSB transmitter, you certainly should own or have access to an oscilloscope for testing and alignment purposes. You can use a scope to check for flat-topping, carrier, and unwanted sideband suppression, etc.

The rf output of the transmitter can be checked by a variety of methods, such as loading it into a bank of light bulbs as a dummy load, and then comparing their intensity driven by the transmitter to their intensity when plugged into the ac line. SWR bridges can also be used to check relative rf output, by comparing the required sensitivity setting for full-scale deflection (always using the same antenna, frequency and power input to the transmitter).

Speaking of SWR bridges, most hams have blind faith in these devices, but they can go sour too. So check them while making your station check by loading into a flat dummy load, to make sure their calibration is still OK. Also, you can check by measuring the SWR, then reversing the bridge in the line and seeing if the SWR reads the same in both directions.

All the station's accessory equipment should also be checked. A little thought will help you make a checklist to suit your own station. You know what the equipment should be capable of; just make sure it's doing all the job correctly.

There are a number of things to check with regard to the antenna system. You could start by making sure the antenna rotator is pointing the same direction as its indicator box. Then make a complete set of physical checks—worn spots on the feedline, kinks in the coax, connectors (for corrosion, mechanical strength, breakage, etc.), guy wires, turnbuckles, ground connections, and so on.

Safety considerations should never be overlooked. Make sure all equipment is properly grounded. All coax should be grounded as it enters the building, and all fuses of the correct value. Be sure that all adult members of your family know how to kill power to the shack in the event you get into trouble.

As you can see, you can make station equipment checks ranging from very fast, simple checks, to tests which will take a number of hours. It all depends on how involved you want to get. The thing for you to do is to sit down and carefully consider just how involved you want to get in a PM program, and then make you check list accordingly.

Even with a good PM program, it is sometimes impossible to avoid sudden equip-

ment failure. To be prepared for these unavoidable failures, you should keep spare tubes and fuses on hand, as well as a few spare components in your junk box. I have always made a practice of keeping a complete set of spare tubes on hand for all radio equipment, to avoid the problem of having a tube failure over a contest weekend, when all the local radio stores are closed.

The table of *Fig.* 1 summarizes some of the things to remember in making up your own PM checklist. Use it as a guide, and adapt it to fit your own needs.

You will enjoy operating more if you avoid the frustration of sudden equipment failure, or reduced station efficiency through improper equipment operation. As Tom Lehrer says, "Be prepared."

EQUIPMENT (GENERAL):
Dust & clean
Check tubes
Dial Calibration
Control functions
Voltage checks
All bands/modes
Noisy controls
Correct value fuses
Spare tubes
Spare fuses
Ground connections

RECEIVER:
Sensitivity
Noise figure
Calibrator frequency
Dial calibration
Frequency stability

ACCESSORIES:
Q-multiplier
SWR bridge
T-R switch
Low-pass filter
Antenna tuner
Control circuits

TRANSMITTER:
Audio quality
Keying quality
rf output
Frequency calibration
Frequency stability
SSB characteristics

ANTENNAS:
Feedline
Coax connectors
Guy wires
Mechanical strength
Rotator

Fig. 1—Checklist Guide for PM program.

. . . K3KMO

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

You Can Pass The Extra

If you can copy press from KFS and KPH which goes out at about 23 wpm, send READABLE code, and know the answers to at least 75% of the License manual or Study Guide questions, there is no reason to muff this test. It's all a matter of your mental and physical attitude when you arrive.

Decide in advance that you are going to take a well-earned holiday and go up to find out what the exam is like, so you will know how to prepare for the NEXT one. No studying or cramming the night before—take the XYL out to dinner and a show. Next morning a very light breakfast or, better yet, none at all. Don't drive your car and arrive tired and tense. Take the train; if you smoke, have a good cigar and enjoy the scenery. At least once, glance over the few tough questions which you have previously marked in red, for a quick review.

The receiving test, which is first, is really very easy. The first 150 letters are plain language; if you miss a letter you can fill it in by inspection. (No, you can't; you don't get time—Ed.) Just try to get the sense of it as you go along remember you are just there to find out what it's like; you don't give a darn one way or the other. There are no mixed code groups as in the commercial exam, no KEIZ de MZL SS Floribel sinking off Point Arena Lat. 38 deg. 50 min. N, long. 123 deg. 47 min. W. SOS SOS SOS. That kind of stuff really separates the men from the boys. (Meet one of the boys—Ed.)

Now that you have passed the receiving test, you have a chance to make a friend of the examiner on the sending test. First get that old rattletrap key into comfortable adjustment and then send a string of V's until your arms and wrist are flexible. Nobody can send readable code with a tense "glass" arm. (I lost more boys to the sending test than any other one thing on the commercial exams.) Remember, don't slur your dots, they are just as important as dashes; send every word solid and firm. Be sure you send words, not just a string of letters which would take a cryptographer to decipher. You think and talk in words, so send that way. Look over each word before you send it; relax your arm or even let go of the key while you look it over. Overlong spacing is a heck of a lot better than too short. And send at a comfortable rate of speed, whether it's 18 wpm or 25 wpm. Even if you are a little slow, the examiner will accept it over ragged unreadable stuff. The real test of a wireless operator is—can he remain cool and send readable code under panic conditions.

If you have maintained your devil-may-care attitude you are now up to the written exam, so don't lose it now. Don't look over all the questions to see how tough they are. Just start with No. 1; if you know it cold answer it. If you aren't sure, pass it up and try No. 2. If you come to one like "Draw a schematic of a radiotelephone transmitter" which is obviously going to take a lot of time, pass it up for now and go on to the end, answering the ones you know cold. Now add up the number you have answered. If it is over 75 percent of the total, hand in your paper, put on your hat and go home. If less, start picking out the easiest of the ones you skipped. Keep working at it until you have over 75%. Remember, on the multiple choice questions you have a 20% chance of being right by just guessing. There is no sitting there and sweating for 4 or 5 hours as some of the fellows do.

If you fail, for another $4.00 you can go back next month and try again. But if you maintain the right attitude, you won't have to. Not your life, not even your job depends on this exam, so keep your cool. Be sure you have a stamped, self-addresses postcard with you to hand to the secretary, and the chances are that you will get it back in Monday's mail with the terse comment "You passed the EXTRA class exam".

. . . K6YA

This article is reprinted from The Footprint, the club bulletin of the Foothills Amateur Radio Society, Palo Alto, California, edited by Jim Lomasney WA6NIL.

Use of Q-Multiplier to Increase Intelligibility of Received Voice Signals

About twenty years ago, a number of amateur and commercial operators discovered, more or less independently, that the intelligibility of weak phone signals could be increased, in some instances, by judicious adjustment of the crystal phasing control. This procedure still works, but requires a happy combination of skill and luck for its successful employment.

A much greater improvement in intelligibility of weak phone signals can be brought about by the use of a properly-adjusted Villard Q-Multiplier. This increased signal improvement is possible because the "slot" of the Q-Multiplier is substantially symmetrical, whereas the "slot" of the crystal is decidedly skewed. In general, this will work wherever a Q-multiplier is effective—at *if* frequencies of 400 kHz or more. At lower *if* frequencies, the Q-multiplier is usually too sharp, and a bridged-T notch filter is used instead. This also can be used to improve intelligibility.

Procedure for improving the intelligibility of a weak phone signal, by use of the Q-multiplier, is as follows:

With the Q-multiplier off, tune in the signal and center it in the *if* passband.

Remove as much heterodyne interference, noise, etc. as possible by use of the crystal filter, noise limiter, etc.

Turn on the Q-multiplier, set it for "null", back off the "null depth" control toward zero, and tune the Q-multiplier exactly to the *if* frequency.

Advance the "null depth" control until intelligibility is at a maximum. This is usually just below the point where male voices start to sound "tinny". Advancing the "null depth" control beyond this point usually degrades the signal.

Rock the Q-multiplier tuning ***slightly*** to be sure that it is exactly centered in the *if* passband.

The effect of this adjustment on received voice signals is as if the modulation percentage were increased, and the mid-audio range (300 to 3,000 Hz, approximately) were boosted.

What the Q-multiplier does here, when properly adjusted, is to reduce the amplitude of the carrier and of the lower frequency side-bands, while passing the mid-frequency sidebands unchanged. As total power through the *if* system has been reduced, AVC voltage is also reduced, producing a drop in the S-meter reading, so that the amplification of the *if* system for those sidebands that are passed is increased. As the intelligibility of voice signals depends mostly upon the mid-audio frequencies, which reach the detector with greater amplitude than previously, the effect is desirable, and leads to a net gain in intelligibility.

This procedure works well with male speech in English, French, Spanish, Portuguese, Italian and Latin. It is less useful with some of the Germanic languages, in which low frequencies are more important than in English; and seems to fail completely with some of the intoned languages, such as Yucateca and Cantonese.

Ronald L. Ives;
2075 Harvard St.
Palo Alto, Calif. 94306

Nat Stinnette W4AYV
Umatilla, Fla.

Crystal Etching Tips

For etching crystal blanks use a saturated solution of ammonium biflouride in a plastic container. The crystal can be held on the edges between two wooden strips which have been fastened at one end and the crystal end suspended in the solution. You don't need a large amount of solution, just enough to cover the crystal. Use another plastic container with clean water and a small amount of baking soda for the first rinse.

Don't assume that all crystal blanks will move the same in a given time period. Some move faster than others. Better make a few trial runs and see how far each blank moves in one minute. It may be as much as 2kHz on some. Don't try to move a blank more than 25 kHz as the activity falls off drastically and it is almost impossible to restore it. If, during your etching, the activity gradually diminishes, this is probably due to the acid rounding off the edges. One swipe on each edge across a piece of fine production finishing paper (3M A wt.) will help square up the edges. Hold the blank straight up and apply light pressure. This will increase the frequency so make the necessary allowance. Also, beveling the edges in the same manner will sometimes pep up activity but this is tricky and not recommended except as a last resort. Rotating one electrode may help.

The blank must be perfectly clean for best operation. Soap and water with a tooth brush for scrubbing is best. Rinse thoroughly. Hold blank on edges between thumb and forefinger when handling to avoid fingerprints on the flat surfaces. Electrodes should be cleaned in the same way. Dry with a clean, lint-free cloth.

Blanks can be moved up and down in frequency as much as 2kHz with different electrodes. If your project calls for just a small movement, it is better to get a supply of electrodes and try them first. Different electrodes produce varying amounts of activity so you may have to choose a compromise set which gives the required output and frequency. Also, the amount of spring tension will affect the frequency. Make final frequency check in the FT-243 holder in the equipment in which it is to be used.

If you are etching blanks for a filter, remember that the input capacity of the oscillator used for frequency checking may be different from the capacity of the filter circuit. Check the filter curve after each etching.

If you plan to do much crystal etching you will find it is a tedious job to remount the crystal in an FT-243 holder after each etching in order to check the frequency and activity. Here's a gadget which will eliminate this headache.

Some series of CR1A/AR holders, usually a brown case, have a rectangular or square insert in which the crystal and electrodes fit. A spring clip is used for pressure instead of the conventional wire spring. It is simple to slip the insert (holding the crystal and electrodes) into the holder along with the spring clip.

The pins on the CR1A/AR holder have the same spacing as FT-243 but are larger in diameter. It is possible to saw off these pins close to the case and solder to the stubs the bottom part of an FT-241 holder (low frequency type, channel 45, etc.). This holder has the same pins as FT-243. If you use a separate oscillator rather than your transmitter for checking frequency, mount a 5-prong socket for the crystal and the CR1A/AR fits perfectly as is.

. . . W4AYV

Operation Salvation Army

Southern California radio "hams" working with The Salvation Army have played a vital role in meeting disaster needs. They are ready to spring into action in the next emergency, whether it be a forest fire, earthquake or any other calamity.

Shortly after its organization in 1959, The Salvation Army Disaster Communications Net, a volunteer organization of radio "hams", proved its worth.

During the week of October 13-20, a major forest fire raged in the Angeles Crest highway section near Los Angeles. The Salvationist forces worked long and hard, bringing coffee and snacks to weary firefighters. Working eight days, 24 hours a day out of an improvised control center set up in the Army's Men's Social Service Center, the Net helped the mobile canteens maintain perfect communication with headquarters.

Although The Salvation Army's canteens, station wagons and trucks were already equipped with two-way radio communication, the Net met an important need. There are certain dead spots from which the Army's own radio transmitters and receivers cannot operate, but the "ham" sets had no difficulty operating on other frequencies. Twelve volunteer operators passed 601 messages during the emergency. Thus, the "Ham" network working closely with the regular Salvation Army Net, provided constant communication with those in the fire area.

Operating with their new crystals for the first time, the "hams" transmitted on 50.250 and 50.850 megacycles with unvarying success. Their range is indicated by the fact that messages from firefighters imported from New Mexico were successfully sent to relatives back home.

Another dramatic instance of effectiveness took place during the Alaskan earthquake of 1964. The Net achieved direct communication with amateur operators in the emergency zone, providing a dependable and important avenue of communication that greatly assisted in forwarding emergency supplies to the areas where they were most needed.

Today the 85 member Net has its headquarters at The Salvation Army's Men's Social Service Center in Los Angeles. The master transmitter and antenna are permanently installed there.

The Net operates at the Long Beach Camp Meetings in August and the County Fair in September, sending messages of greeting to all parts of the nation free of charge.

Once a year it holds a dinner and election of officers at the center. Notable authorities in the broadcasting field are guest speakers.

To insure readiness, there are equipment checks of all transmitters every two weeks. In addition, a roll call is held on the air every Wednesday evening, when all forty transmitters are in direct communication with the master transmitter.

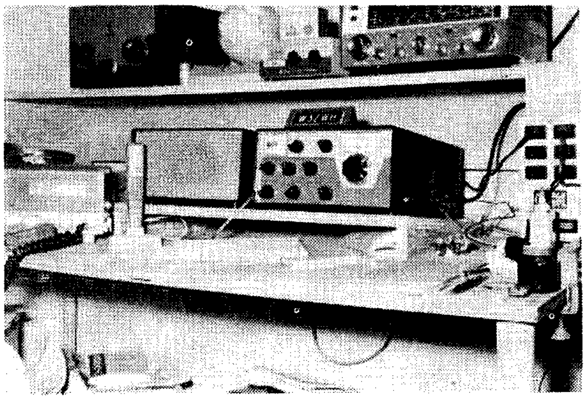
Location of the Net's headquarters at the Men's Social Service building makes possible close cooperation between the two groups. Manpower, kitchen facilities and garage services are right at hand and available on a 24 hour basis—invaluable when disaster strikes.

Disaster service is only one aspect of The Salvation Army's extensive spiritual and social welfare ministry which seeks to meet need at the point of need. Hospitals, day nurseries, centers for alcoholics and homeless men, community centers and counseling services are among the various other ways in which The Salvation Army extends a helping hand.

The Salvation Army Disaster Communications Net hopes disasters are far off—but is prepared to spring into action on thirty minutes' notice whenever needed.

Tilt Your Rig

Do you find it uncomfortable to see your receiver or transceiver dial or to turn the knobs? If so, this little shelf which fits on top of your operating desk may be just what you need. By tilting your rig up where it is easy to see and operate, this sloping shelf will add immeasurably to your operating ease and comfort. And, the shelf is cheap and easy to construct.



As you can see, construction of the shelf is utter simplicity. Mine is made of ¾ inch plywood. This was used, because it was available, and because I did not want the shelf to sag under the weight of the power supply and transceiver.

Wood screws hold the three pieces of wood together. Holes were drilled to match the feet on the bottom of my equipment. These holes as well as the dimensions of the shelf can, of course, be varied to suit your individual needs. Also, by leaving the front of the shelf open, you will have a handy storage space for logs, pencils, etc.

Finish the shelf with a coat of paint, and that's all there is to it. Build one and you'll be surprised at the difference it makes in operating convenience.

. . . Joseph M. Plesich W8DYF

Propagation Chart

APRIL 1968

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14A	14	7A	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	7	14	21	28	21A	21	21	21
AUSTRALIA	21	21	14	14	7B	7B	14	14A	14	14	21	21
CANAL ZONE	21	14	14	14	7A	14	21	21	21A	28	21A	21
ENGLAND	14	7A	7	7	7A	14	14	14	21	21	21	14
HAWAII	21A	21	14	7B	7	7	7B	14B	14	21	21	21
INDIA	14	14	14B	7B	7B	14B	14	14	14	14	14	14
JAPAN	14A	14	14	7B	7B	7B	14B	14B	14	14B	14	14A
MEXICO	21A	14	14	14	7A	7	14	21	21	21	21A	21A
PHILIPPINES	14A	14	14	7B	7B	7B	14B	14	14	14	14B	14
PUERTO RICO	14	14	14	14	7A	14	14	14	21	21	21	21
SOUTH AFRICA	14	14	7B	14	14B	21	21A	21A	28	28	21A	21
U. S. S. R.	7B	7	7	7	7B	14	14	14	14	14	14	14
WEST COAST	21A	21	14	14	7A	7A	14	14	14	21	21	21

CENTRAL UNITED STATES TO:

ALASKA	14A	14A	14	7A	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	14	7	14A	21	21A	21A	21	21
AUSTRALIA	21A	21	14	14	14	14	14B	14	14	14	21	21A
CANAL ZONE	21	14A	14	14	14	7A	14	21	21	28	28	28
ENGLAND	14	7A	7	7	7	7A	14	14	14	21	21	14
HAWAII	21A	21	14	14	14	7A	7A	14	21	21	21	21A
INDIA	14	14	14	14B	7B	7B	14B	14	14	14	14	14
JAPAN	14A	14	14	14B	7B	7B	7B	14B	14	14	14	14
MEXICO	14	14	7A	7	7	7	7	14	14	14	21	21
PHILIPPINES	21	21	14	7B	7B	7B	7B	14	14	14	14B	14
PUERTO RICO	21	14	14	14	14	14	14	21	21	21	21	21A
SOUTH AFRICA	21	14	7B	14	14B	14	21	21	21	21	21A	21A
U. S. S. R.	7B	7	7	7	7	7B	14	14	14	14	14	14

WESTERN UNITED STATES TO:

ALASKA	21	21	14	14	7A	7	7	7	14	14	14	14
ARGENTINA	21	21	21	14	14	14	14	21	21	21	21	28
AUSTRALIA	28	28	28	21A	21	21	14	14	14	14	21A	28
CANAL ZONE	28	21	14A	14	14	14	14	21	21A	28	28	28
ENGLAND	14	7B	7	7	7	7	7B	14	14	14	14A	14
HAWAII	28	28	21A	21	14	14	14	7A	14A	21	21A	28
INDIA	14A	21	14	14	7B	7B	7B	14B	14	14	14	14
JAPAN	21	21A	21	14	14	14B	7	7	14	14	14	21
MEXICO	21	14	14	7A	7A	7	7	14	14	14	21	21
PHILIPPINES	21	21A	21	14	14	14	14B	14	14	14	14B	21
PUERTO RICO	21	21	14	14	14	14	14	21	21	21	21A	21A
SOUTH AFRICA	14	14	7B	7B	7B	7B	14B	14	21	21	21	21A
U. S. S. R.	7B	7B	7B	7	7	7B	7B	14B	14	14	14	14B
EAST COAST	21A	21	14	14	7A	7A	14	14	14	21	21	21

A. Next higher frequency may be useful at this hour.

B. Very difficult circuit this hour.

Good: 1-4, 6-8, 15, 16, 18-20, 22, 23, 25-27, 29, 30
Fair: 5, 11-14, 17, 21, 24, 28
Poor: 9, 10
VHF: 14-17, 22, 26

station transmitting. And any one of the stations can alert all of the others when something is spotted.

If we were to establish a net frequency on 80, 40 and 20 meters for UFO reporting we could arrange for a single tone to be transmitted when an alert came along which would turn on all of the loudspeakers of participating stations. Thus all of us could have a receiver set up on a net channel all of the time, running silently. Amateurs in every community in the country could ask their local police, CD, etc., to call them immediately if any sightings are reported.

When something is reported anywhere the local amateur station would call in on the net and the net control would send the tone to alert the entire net. Once the area of the contact was established amateurs in the area toward which the UFO was headed could alert their police and any others interested. If scientific teams are ever available they would have a warning and might be able to intercept the UFO's.

A net like this could be formed immediately and could build as interest widened. All it takes is one single man with the interest and time to make it click. One man, if he has a good station, could start in as net control and open the net evenings as a starter. Eventually the net should be open around the clock, I should think. The automatic alert can come along later, though it is simple enough. A two-tone oscillator into a sideband transmitter will give out a nice audio tone for operating relays on quieted receivers. We used to send RTTY messages like that twenty years or so ago, so it works well. Simple too.

In terms of value provided by amateur radio to our country a service like this could dwarf everything else we have ever done. Just one good UFO success and we will have paid for ourselves thousands of times over. And think of the enormous publicity we would receive just for setting up such a reporting system. This would be in every newspaper in the country, if not the world, and would be there over and over. All the police forces in the country would be familiarized with us and would depend on us for their UFO communications. And if the government ever takes a serious interest in the problem they, too, would be entirely dependent upon us for communications.

If anyone is interested in going ahead and forming a UFO reporting net why not

get together on, say, 14250 as a starter. It may take a few weeks to get going, but seldom does a week go by without there being a reasonably valid UFO report around the U.S. Let me know by mail what is going on and I'll report it in 73.

Step Two

If we are able to provide the depth and breadth of communications needed to bring the UFO problem to a head and it turns out that they are, as so many people sincerely believe, space craft, then the next step is to make some attempt to communicate with them. Here again amateurs have a big advantage over everyone else. We are everywhere. We can organize radio, light, and other mediums of attempted communications and have a fair chance at them because our net will tell us where the UFO's are at any moment and give us a good idea of where they are heading next. If I have a chance to set up my surplus signal light a few minutes ahead, I can guarantee that the UFO pilots will have to be blind to miss it.

First things first. Please don't let me and everyone down by leaving the UFO reporting net to someone else. If you can't get on 14250 you might try 7250 or 3900 kHz. Let's GO.

73 SUBSCRIPTION BLANK

What with the devaluing of the pound, the drain on gold and the recent increase in postal rates, obviously 73 is going to have to raise the subscription rates soon. They are still the same for now.

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____ $1 Transistor Ckts
____ $1 Diode Circuits
____ $1.50 Index to Surplus
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Alfred Wilson W6NIF
3928 Alameda Dr.
San Diego, Calif. 92103

Take Uncle Alf's Advice and You Will Do All Right

It's a nice day today, but band conditions are lousy. Why don't we drop in on Uncle Alf and see what's going on over at his place? He is a DXer of some accomplishment, and sometimes one can pick up some real nuggets of wisdom by sitting quietly in the corner with an ear open. True, it's sometimes necessary to switch in a 200 Hz filter to eliminate some of the stuff that goes on. But generally Uncle Alf has been known to put out some pretty good data from time-to-time.

Right now Uncle Alf is pounding away on his old Oliver typewriter trying to make a buck so he can replace his 4-250A that blew during the DX test. That tube made a rather good but expensive fuse, with 3 kV on the plate with nowhere to go but up, and no −150 volts on the grid. But that's the breaks . . . win a few, lose a few.

Anyway, Uncle Alf is working away when the screen door bangs, and in walks Simple Simon Q. Sideband from over at Finksville Jct, looking down-at-the-mouth. Very sad, indeed. He is clutching a bundle under his arm.

Uncle Alf is smoking his pipe, so S. S. offers him a cigarette. "What do you hear, old buddy?" says Uncle Alf. He thinks maybe S.S. is returning the grid dipper he borrowed last summer, but S. S. unwraps the package and tosses a hank of co-ax cable and some number 14 wire onto the table.

"Uncle Alf," says S. S., "See this stuff? I put myself in hock to the tune of $36.95 with the Finksville Friendly Financial Foundation so's I could buy it, and it ain't working worth a darn."

Knowing already what's the problem, Uncle Alf says, "I see it. What's the problem?"

Simple Simon says, "Well. It's a custom-made inverted Vee dipole, supposed to have real low radiation angle such as is pre-ferred by them DX signals on twenty and fifteen. But it acts crazy." Uncle Alf is tempted to say something appropriate like, "You should know," but instead he picks up the wire and looks at the feed point.

"Simple S. old buddy," says Uncle Alf, "what happens to your TV set when you fire this thing up?"

Simple looks kind of sheepish. "Yeah. That's another thing I was going to mention," he says. "I was in this pileup yesterday when I heard a terrible crash. Seems that ole Missus Figbottom next door snuck over and cut down my guy wires. I guess her TV set had a slight attack of raster disaster." S. S. starts picking up little bits of solder off the workbench. "Waste not want not, I always say," he mutters, and sticks them into his pants cuffs.

A wave of pity sweeps over Uncle Alf and he says, "S. S., I am going to impart to you some very interesting data. I am going to dip into my good oats bin and show you how to resolve your problem."

S. S. looks pleased. "I read you good, Uncle Alf. Dah-de-dah. That means "go" to you CW types," he smiles.

Uncle Alf, who has never worked phone in his life and never intends to, picks up the wire. "Just look at this (ptui!) antenna you are using," he says, tapping the feed point.

"Like I said, it cost a lot of scratch," says Simple S. "What is wrong with it?"

"Well," says Uncle Alf, who has been a ham for 32 years and is knowledgeable in this area, "in the first place, you can't feed a balanced system with an unbalanced transmission line and expect the thing to work right. Your TVI is probably being caused by radiation from the feed line. These inverted Vees, which is a misnomer because they are not true Vees, work pretty good if, and only if, they are properly fed. What you need is a method to get rid of antenna currents on the line, old buddy."

"Aw, I already tried that," says S.S. "I put a quarter wavelength of RG-8/U on the line exactly as it says in THE handbook, but I still got the TVI."

Uncle Alf restokes his pipe. "How do you know it was a quarter wavelength long?"

S.S. picks up THE handbook. "Right here, on page 331, see? This picture shows a dipole fed with co-ax and a linear balun (whatever that is). It says the balun should be a quarter wavelength long. I measured mine like THE handbook says."

"What it doesn't say, among other things," says Uncle Alf, "is how far the co-ax balun should be spaced from the transmission line, assuming both line and balun are the same material, as in your case. The dielectric between the line and balun affects the velocity factor of the balun, which in turn affects the electrical length. If you strap the balun right onto the line, the vinyl jackets will constitute an appreciable part of the dielectric between line and balun. The old formula for finding the physical length for a quarter-wave section is fine, but you got to plug in the right number for V, the velocity factor. Now, if the balun and line are air spaced between one half and one inch, then the velocity factor is something different."

Simple S. wags his head in awe. "Oh what knowledgeable words you are sending," he says, "but what should the length be for my balun if I want it to work on 14 MHz, say?"

"If you are going to tape the balun to the line, the balun should be 11.5 feet long. However, if you space the balun away from the line about an inch, the balun length should be 16.6 feet."

Simple Simon says, "Uncle Alf, I wonder how come they don't tell that good data in this here handbook? They been printing it for years with the same stuff, never changing it, and seems to me they could put that velocity factor business in with the directions on the balun where it will be useful."

Uncle Alf's eyes narrow, and a wicked grin appears on his handsome features. "Oh so right, S. S. old buddy. However, let us not belabor the point now. Maybe someday somebody will do something about that."

S. S. picks up his junk and gets ready to leave. He says, "You know, Uncle Alf, you are so kind and generous to program me on how to cure my TVI troubles, I am going to let you in on a little secret. I found a way to really make them rare DX ops sit up and take notice when I send them my QSL cards."

"Yeah?" says Uncle Alf, "how's that?"

"All's you do is paste on some of them Chiquita Banana stickers. Man, that really gets results."

"Yeah," says U. A. "Thanks. I'll store that little tidbit into my memory core for future reference. Never can tell when it might come in handy for a little do-it-yourself hint."

. . . W6NIF

Letters

Dear 73,

I would just like to sit down and take a minute to express my sincere appreciation to the FCC for the forthright manner in which they handled this incentive licensing program.

In spite of continual griping and pressure from selfish (lazy?) amateurs and others, they went right ahead and did something which needed to be done, and I for one am with them 100%

Remember that FCC rules shoud not be based on "popularity", but on what is for the best interest of the public at large, and this incentive licensing cannot help but take a long step in that direction.

Richard B. "Red" Blanchard, Jr. W6AG
No. Hollywood, Calif.

Dear 73,

. . . I have often read articles establishing amateur radio as a hobby and public service vehicle. It is one that has many facets, ie: building, CW, traffic handling, rag chewing, and experimenting. These very articles establish an obvious fact, that all people are not interested in the same things and that "hamming" is attractive for one reason, amongst others, that it offers many things to many people.

For those among us who are "only" operators, who pass traffic, handle phone patches, who take the time and effort to study for and pass the technical and CW tests for their very coveted and totally enjoyed license and who are proud to be hams, I offer this thought. To select that portion of hamming that interests you most and to do it to the best of your ability doesn't leave you open to justified criticism.

Lawrence J. Felman WB2ZRR
Parsippany, New Jersey

Dear 73,

Amateur radio is dying and the FCC is burying it. The new incentive licensing will do that nicely.

If the idea is to attract newcomers to ham radio and to keep ham ops advancing the technical phases of the art, the last thing that is needed is a higher code speed. Some people cannot copy code at 13 WPM.

If new advances in the technology are desirable, lets promote that instead of a higher code speed and give the phone operator something to shoot for. How about a Technician Advanced Class requiring 5 WPM and the Advanced technical test allowing operation on low band phone? This would eliminate the appliance operator and give the technician a chance at technical advancement in HF as well as VHF. Why make the phone man up his code speed to stay in business?

John Beal WA9UKH
Wauwatosa, Wisconsin

Dear 73,

I enjoyed reading your article in Jan. 1968 edition, on Boy Scout Jamboree. I believe the article and picture will explain to some people the Scouts interest in amateur radio. One of their First Class requirements is Signaling, either by Morse or Semaphore code.

Your last line of the article, "What better way to get youngsters interested in our great hobby than activity like this one with the Scouts", sums up my feelings about Scouting and hamming.

Paul Thoerner WA8DFH
Dayton, Ohio

Dear 73,

I am writing this letter in reference to the article **Novice Data** by Bill Welsh W6DDB, in the January 1968 issue. I wish to call attention to his instructions on how to establish contact. It says that in calling CQ, answering a CQ, and during a contact, one is to conclude his transmission with "AR K". These instructions do not agree with pages 19 and 20 of the **ARRL Operating Manual.** Here is it clearly stated that when CQ is called "K" and not "AR" or "AR K" is to be used. It goes on to say that the answer to a CQ is to be concluded with "AR" not "K". Many hams are writing articles about improving operating practice, but we will get nowhere if misinformation is published.

David F. Jambor WN2CDI
New Brunswick, N.J.

I couldn't agree more, David. However, FCC and not ARRL is the authority we must follow on regulations. This section is rather vague, but in examples given the calling station is to use "AR" at the end of a transmission and the answering stations signs "K".

Dear 73,

Back in the early 1920's, some of us early experimenters thought we heard signals from outer space. In fact, the Army did believe this enough to erect some antennas and do considerable listening on the VLF and BCB wavelengths. For some thirty years, I have had to all but give up DXing and experimenting. Now being on a pension, I can once again satisfy my curiosity regarding whether or not what we thought were signals from space were but hydrogen emanations from some unknown source.

Now I am wondering whether or not the "UFO's" have ever tried to communicate with us also. While I have observed these objects all the way from up around Bethlehem to Key West, I still don't know anything factual about them. So, I am wondering if you would print a short request asking any hams that have any opinions on the subject to contact me. If this is done, I will act as a clearing house for this information and keep you informed of what I learn.

Carl L. Horton WN3JET
3753 Kanawha St., N.W.
Washington, D.C. 20015

Dear 73,

Don Marquardt is a traitor!

In his August article, "A Simple Cavity for Six Meters," he starts out great by pointing out the honest merits of a transmitter cavity; the reduction of TVI by minimization of fundamental-frequency harmonics. But in the second paragraph he blows the whole thing by virtually promising that the cavity would eliminate channel 2 interference.

A great many of us on six meters have tried very hard to educate our neighbors to the fact that in **most** cases, channel 2 interference is attributable to an excessive broad TV front end; and that **nothing** can be done at the transmitting point to alleviate the problem . . . the only practicable answer to channel 2 headaches is viewer education.

I strongly suggest that author Marquardt needs to do some boning up on adjacent channel interference And, for a starter, I humbly refer him to my own article, "The Key to Peaceful Coexistence (Between Six Meters and Channel 2)" which appeared in the February 1966 issue of **73 Magazine.**

Ken W. Sessions, Jr. K6MVH
Ontario, California

Dear 73,

I would just like to take this opportunity to congratulate you for publishing the best magazine in the electronic field. I have ample opportunity to review many technical electronic publications here on the campus of MSU, but none are more up-to-date than 73. I have been constructing several transistor projects, the circuits for which I was unable to find anywhere except in 73.

Jim Stermitz WA7AZN
Bozeman, Montana

Dear 73,

I understand that you stand behind your advertisers, and that an ad in 73 implies integrity and service. I am writing in reference to an ad on page 96 of the December 1967 issue of 73, placed by "Pete" Fragale W8AEN. A few weeks ago, I developed a need for some heavy duty diodes, and spotted Pete's unobtrusive ad in 73. I placed an order with Pete for 21 epoxy diodes, and asked him to fill my order as soon as possible because my transmitter was out of commission for lack of plate power until I received them. In less than a week, I had the diodes. Pete had sent the order Air Mail Postpaid. Not only that, he included three extra diodes free.

Just wanted to let you know how reassuring it made one of your readers feel to find a businessman as interested in giving service as in making a buck.

73 continues to be superb. Keep up the good work.

Stanley L. Tippin W4VMR
Valparaiso, Florida

Dear 73,

Hope you like the verse attached.

Lady Editor

Hurrah for Kayla at "Seventy Three",
It needed the woman's touch
For warmth and charm in its chapters
And sparkle which means so much.
To carry the cause of the gentle ones,
Make adjustments here and there,
And develop this wonderful craft of ours
To a truly family affair.
An appeal to all ages, both boys and girls,
May the amateur story be sung,
A blend of service, of technique and fun,
To keep us forever young.
We have a motion to pass along,
My XYL says it is great,
On the cover, lets follow the 73
By a slant bar 88!

Dan A. Hoover W9VEY
Lafayette, Louisiana

Dear 73,

We want to congratulate you on the great magazine you are publishing for the ham fraternity. We like the attitude that every reader is not an experienced engineer. We especially enjoyed the series of articles on the novice subject. The easily understood technical articles are especially helpful and meaningful to a new ham.

Being only on AM, we would appreciate any information on conversion to DSB. 73 indicated that conversion was a rather simple matter, but we do need some procedural instruction.

Henry G. Davis, Jr. WA9TNL
Maywood, Illinois

A DSB conversion article will appear in an early issue. The drawings are being prepared at this time.

THE HERB GORDON SWAMPSCOTT HAMFEST SPECIAL!!

So as to enable the maximum number of hams to get the very best value in a 5 band SSB transceiver, and also as a means of expressing our thanks for the business which you have given us over the past several years, we are making the following unusual offer.

At Swampscott we will have a substantial number of factory fresh National NCX-200's, the very latest versions, with both their supply and our husky meat and potato power supply kit, stacked up in our large, double-sized display booth, at these very unusual combination prices. **For the NCX-200 with our meat and potato power supply kit, $379.95. For the National NCX-200 and their AC-200 power supply, $399.95.**

The National NCX-200 is an attractive, high performance, modern sideband transceiver, created by National's experts, to operate over the 5 ham bands, 10 through 80 meters, with 600 kc of coverage per band. This permits an extra hundred kc of coverage outside the band for MARS operation. The NCX-200 features a solid state balanced modulator for exceptional stability and suppression of carrier. Also, it provides fully automatic AM or CW carrier emission, as proven out on the famous National NCX-5. Excellent ALC characteristics and a 4 pole, 5.2 megacycle filter with 2.8 kc of band width are provided in the NCX-200. The power capabilities vary, depending upon the power supply selected, from 200 watts to 400 watts. We will have on display an NCX-200 equipped with our meat and potato power supply and some simple changes which will demonstrate smooth operation with over 250 watts of RMS out into a Waters watt meter. The NCX-200 will provide for CW, AM, or sideband modes of emission on all bands. This set is particularly appealing to beginners and those making their first change from AM to sideband. Clean, sharp talk power are yours at the lowest possible price for a 5 band set, with this Ham Fest Special.

Moreover, since we are in a mood to want to do business with you, in addition to shaking your hand and saying hello, we will be prepared to evaluate your equipment which you want to trade, at that particular time. So bring your gear in with you and let's talk turkey. In short, what we are offering you is the opportunity to enjoy the best deal in the nation while you are enjoying the best ham show in the nation.

Compare these prices, and then decide and schedule your trip to the ham fest. You will obviously save enough to more than pay for the cost of your week-end. To those unable to make the show, write in to us. The same deal is yours; just mention the Swampscott Ham Fest Special, and tell us what you have to trade, or otherwise make remittance and we'll see to it that the best deal is available to you, too.

HERBERT W. GORDON COMPANY

Harvard, Massachusetts 01451 • Telephone 617 + 456 + 3548

"Helping Hams to Help Themselves"

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★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

SELL: Magazines; EICO 536A; complete ATV Experimenter; 2.4" telescope; 5 transistor amplifier; Johnson low pass. Stephen Clifton, WA2TYF, 800 West End Avenue, N.Y., N.Y. 10025.

RESCUE THE GOOD 'OL SPIRIT OF AM ham radio from the cost and complexity of SSB! Now you can build that long awaited 500-watt plate modulation system complete for less than $50! Cost reducing plan only $1.50. Write: Tradewinds, P.O. Box 1254, Fort Wayne, Indiana.

QSLS??? Large variety samples 35¢. Sakkers Printery, W8DED, Holland, Michigan.

CHRISTIAN HAM FELLOWSHIP now being organized for fellowship and gospel tract efforts among hams. Christian Ham Callbook $1 donated. Free details write Christian Ham Fellowship, Box 218, Holland, Michigan 49423.

RUBBER ADDRESS STAMP including call letters in exchange for one silver dollar, any year, for my private collection. Cheryl Lynn, Box 1111, Homestead, Florida 33030.

FOR SALE: Lafayette HA-350 receiver, DX-60 xmtr., Hy-Gain 80-10 Vertical trap. All in good condx. Will ship. First $200.00 M.O. takes it. WA9QMY, R.R.2 Box 34-A, Berne, Ind. 46711.

FOR QUICK SALE: NCX-3 transceiver, NCX-A ac supply, NCX-D dc supply. Sold together only. Excellent condition. Write: WA9RNP, 1211 Fairfield Ave., Indianapolis, Indiana 46205.

SWAP—WANT: Have two nice Collins R-388 (51J-3)s that I would like to trade for one Collins R390A or R391. Have other items also. Also will sell R388 for $395.00 FOB each. Need Collins PTO type 70HIZ. State price and condition. Inquiries or offers on above invited. P. F. Collins K9BJN, A317-452-6662.

TRADE, EICO 753, s s vfo, h b power supply, for early American FLINTLOCK rifles or pistols. Write: Andrew R. Sabol, 301 Osborne Ave., Waterville, N.Y. 13480.

SBE-33 SSB TRANSCEIVER—Perfect; in original carton, with complete instructions. First check for $180 buys. Stephen O. Cook W8GXN, 1344 Marion St., Niles, Michigan 49120.

COLLINS 51J-4 serial 6129, mint condition, $650. Tektronix 531, $500. Hewlett Packard 150A Oscilloscope, $500. New London 100B FM signal generator, $300. Balantine 314 ACVTVM, $125. Plus lots more. Roger M. Miller, 6521 30th Ave. No., St. Petersburg, Florida 33710, Phone 343-1427.

WANTED: HRO-500 low freq preamp also rec'vr carrying case, cash or trade. E. M. Fischer, RT3 Box 544, Anacortes, Wn 98221.

THE MOULTRIE AMATEUR RADIO KLUB is having it's 7th annual hamfest being held at Sullivan, Illinois, in the American Legion Pavilion, April 28, 1968.

WANTED: Electrically controlled crank-up tower 70' or taller. Must be reasonably priced. Don Gallagher K8WZX, 4908 Lefferson Rd., Middletown, Ohio 45042.

SBE-33 FOR SALE. 80-15 meters SSB transceiver 135 watts. Good condition for $168. I pay postage. WB2VTP, Don Nausbaum, 167 Loines Avenue, Merrick, N.Y. 11566. 516-MA3-5808.

KEYER SALE: Omega DA Digital Automatic I.C. Keyer (with DA-3 option) $65, postpaid. Mint condition. WB6YVW, 1755 N. Wilcox, Hollywood, Calif. 90028.

WRL's used gear has trial-guarantee-terms. SB300—$249.95; SS1R—$399.95; 75S-1—$299.95; Apache—$99.95; HA-10—$189.95; SX99—$89.95; G76—$79.95; 910A—$209.95; Thor V1 & AC—$149.95; HW12—$89.95; HW32—$89.95. New lower prices on hundreds more. Free "blue book" listing. WRL, Box 919, Council Bluffs, Iowa 51501.

FRESNO HAMFEST is May 3-4-5 and you shouldn't miss it. Advance registration is $8, including all the goodies and the banquet Saturday night. Code test, technical talks, mobile judging, transmitter hunts, Novice clinic, etc. At the Tropical Lodge, 4601 N. Blackstone, Fresno, Calif.

TRADE/SELL: NC-125, Heathkit RX-1, VF-1, D-104. Want: HAM-M, KWM-1 DC supply, mount, 312B-2 console, 30L-1/equivalent. Offers? K6SDE, 432 Rosario Dr., Santa Barbara, Calif.

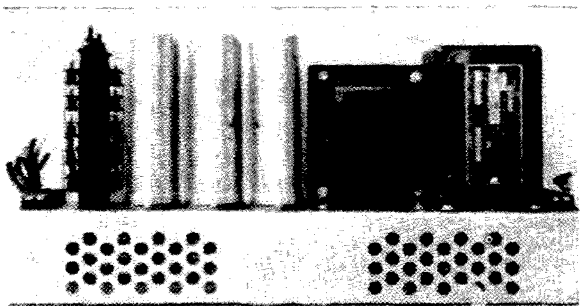
HAMMARLUND HQ-180, National HRO-60 with coils. Perfect. Sell one, $200 or best offer. Virgil Pfeifer, 1605 Gilbert, Peoria, Ill. 61604.

SELL OR SWAP: HT-37, FB for first SSB rig, $195. HX-11 Xmtr, FB for Novice. $35. David Brueni, R.R. 1, Dickinson, North Dakota 58601.
CLEGG 99'er asking $65, Dumont 208B 5" scope with manual $70. Les Kalmus, K2SHL. 201 E. 18 St., Brooklyn, N.Y. 11226. 212-IN2-7250.

4-TRANSISTORIZED PROGRESS LINE GE mobile units, 150-174 Mc, 80 watt output complete with accessories like new, no junk! $450 each; 2—30 watt sets, $400 each; 2—50 watt base stations $375, 30 to 54 Mc 500 watt GE FM transmitter in 6' cabinet with meters, uses pair of 4-125's. Meets present technical requirements if commercial use is desired $350. 2—150 Mc solid state voice Commander walkie-talkies with Nicad pwr supply $200 ea. KWS-1 unaltered & good shape—best offer in 30 days. W9DSV, Box 87, Webster, Wisc.

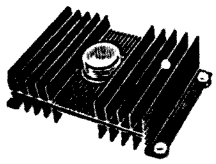
FOR SALE: Collins 75S-3C SN 10411 w/AM filter, 200 cycle crystal filter, Collins suitcase, all $575. H. Lund, RCA Antigua, Patrick AFB, Fla. 32925.

HEATH SB-301 in factory sealed carton after check and alignment. Never used $260. HQ-170C $185. D. Callaway, Rt. 1 Box 303, Durango, Colo. 81301.



SOLID STATE REGULATED FILTERED power supplies, made for 19" panel mount although not all have panels affixed. 115 volt 60 cycle input. Picture above shows typical layout. Offered as a SURPLUS SPECIAL.

#68-3 OUTPUT	10VDC 10 Amp	**$20.00**
#68-4 OUTPUT	135 VDC 2.3 amp	
	15 VDC 7 amp	25.00



TRANSISTOR HEAT SINK

w/2N174A **$2.50**

IBM WIRED MEMORY FRAMES.

Removed from high priced computors. Exlnt condition.

160 core	$ 4.00
1,000 core	10.00
4,096 core	12.50
8,192 core	15.00
16,384 core	35.00

4X250 SOCKET w/chimney & plate ring...**$4.00**

29 VOLT 50 AMP DC REGULATED

Operate on 115 volt 60 cycle input with output of 29 volts DC 50 amps filtered and regulated. Solid state components with standard 19 Inch rack panel mounting. Excellent condition. Shipping wgt. 175 lbs. **$75.00**

29 VOLTS DC 40 AMPS REGULATED

Same type power supply as above with lesser output of 40 amps. **$65.00**

1600 VOLTS DC 1.8 AMPS REGULATED

Solid state circuitry, 115 volt 60 cycle input, rack panel mounting, filtered with 0.5% ripple. Only a few of these on hand. Shipping wgt. 175 lbs. **$75.00**

1 AMP MIDGET SILICON DIODES

1000 PIV 35¢ each 12 for $3.50
1600 PIV 60¢ each 12 for $6.00

1968 **CATALOG NOW READY** 25c

All material FOB Lynn, Mass.

MESHNA

19 ALLERTON ST., LYNN, MASS. 01904

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB P. Wandelt, RD # 1, Unadilla, New York 13849.

NATIONAL NC303, 6 meter converter, XCU-27 calibrator, mint condition, $275. Utica 650 Six meter transceiver, VFO, mike, $130. Richard Ravich, 10 Coolidge Road, Marblehead, Mass. 01945.

DAYTON HAMVENTION April 27, 1968—Wampler Arena Center, Dayton, Ohio, sponsored by Dayton Amateur Radio Association. QSO in person at the nations foremost radio event of the year. Technical sessions, exhibits, hidden transmitter hunt. Bring the XYL for an outstanding Ladies program. Join the satisfied participants who return year after year. Watch the Ham ads for information or write Dayton Hamvention, Box 44, Dayton, Ohio 45401.

DUMMY LOAD 50 ohms, flat 80 through 2 meters, coax connector, power to 1 kw. Kit, $7.95, wired $11.95, pp Ham KITS, Box 175, Cranford, N.J.

MECHANICAL ELECTRONIC DEVICES CATALOG 10¢ . . . Teletype Model 14 reperforator with automatic tape take up rewinder 115VAC 60cy. Both units new, unused $69.95 . . . ARR27 Receiver 29 tubes 465-510 MHz w/60 MHz if new, unused $35 . . . 1/16 laminated copper clad 2 oz. 2 sides, for printed circuits 9½x4½ $1 . . . 3/$2. Transistor boards bonzana $5.95 . . . Wide band balanced modulator $4.95 . . . 30 MHz IF Assembly $5.95 . . . Transmitter TDG w/Modulator easily converted to 2 meters $49.95 . . . Low pass filter 0-32 MHz 52 ohm $9.95 . . . 5KV/2KV/IKV at 750 ma/200ma/250ma Power supply write for details. Fertik's, 5249 "D", Phila., Pa. 19120.

THE NORTH JERSEY DX ASSOCIATION is sponsoring its annual DX Round-Up on Saturday, March 23, 1968. This is the Saturday following the IEEE Convention in New York and it is expected that many out-of-towners will find it convenient to attend. Site of the Round-Up is the Holiday Inn, Wayne, N.J. at the intersection of Route 46 and Route 23, just 30 minutes west of the George Washington Bridge. The afternoon program starts at 2 P.M. and banquet at 7 P.M. Further details available from W2PXR.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

MOTOROLA new miniature seven tube 455 kc if amplified discriminator with circuit diagram. Complete at $2.50 each plus postage 50¢ each unit. R and R Electronics, 1953 South Yellowsprings, Springfield, Ohio.

TOROIDS—DIODES—COAX—CONNECTORS. 88 *mH toroids*—45¢ each, 5/$2.00. 1000 PIV 1 Amp Top-Hat Diodes—55¢ ea., 2/$1.00. Connectors, PL259, SO-239, M359—45¢ ea. 10/$4.00. Button feed-throughs (while they last) 500 pF @ 500 V. 20/$1.00. Add sufficient postage. R and R ELECTRONICS, 1953 S. Yellowstone St., Springfield, Ohio.

VARIACS—General Radio and Ohmite, 60 cycles Input 120V—output 0-280 V. 1 amp or input 240 V —output 0-280 V. 2 amp. PULLOUTS IN GUARANTEED EXCELLENT CONDITION $6.95 plus postage. Shipping weight 10 lb. R & R ELECTRONICS, 1953 S. Yellowspring St., Springfield, Ohio.

DISCOUNT PRICES—Time payments, big savings on new equipment in Factory sealed cartons with full warranty. Swan SW-500C $445, SW-350C $365, SW-250 $286, National NC-200 $315, NCL-2000 $595, Galaxy V Mark II $365, Drake R-4B $375, T-4XB $375, L-4B $595, Ham-M rotator and indicator $99.95. All equipment new, full warranty, factory sealed cartons. Time payments on any purchase. No finance charge if paid within 60 days. Write for discount prices on Hy-Gain, Mosley, Tri-Ex, Hammarlund, New-Tronics, SBE. Immediate delivery. Reconditioned Specials 2-B $189, NCX-3 $199, 32V-2 $99, 75A-1 $129. Send for list. Bryan Edwards Electronics, 1314 - 19th Street, Lubbock, Texas. Phone 806-762-8759.

GENUINE FIBERGLASS CIRCUITBOARD. Over 250 Square Inches of .130 single and double clad, easy to cut. $2 postage paid. G. Beene, 1242 Coleman, Greenville, Texas 75401.

HALLICRAFTERS SX101A Receiver $150. Heath HO-10 Monitor scope $50. Hallicrafter HA6 transceiver & PS supply $125.00. All in excellent condition. Must sell soon. Wilbur Orr, 97 Green-Clover Dr., Henrietta, N.Y. 14467.

HEATH DX-100 with book $80; National NC-190 receiver, perfect, original carton, look, $175. Both $225. K3BGZ, Rt 2 Box 20-A, Leonardtown, Md. 20650.

KITS WIRED AND ALIGNED: Transmitters - receivers - amplifiers - anything; Rate—thirty percent of kit price. Carey Cranford Coggins Industrial Laboratories; 7235 Hunters Branch Drive, Atlanta, Georgia.

NATIONAL NCX-3, NCXA ac supply, like new, original carton, manual, first $250.00 gets it shipping paid. Eugene Gossett, 762 Maple St., Spartanburg, S.C. 29302.

JOHNSON INVADER like new, Tapetone Rcvr converted Valiant command sets, send for list. Thomas, 11 Sussex North, Lindsay, Ontario, Canada.

SWAN 250 AC DC power used 3 times vox calibrator 444 mike $450.00 delivery 250 miles. John Oezer, P.O. Box 97, DeMotte, Ind. 46310.

GROUNDED GRID FILAMENT CHOKES, 30 AMPS, Ferrite core, Bifilar wound, $4.00. Plate chokes 800mA. $2.00. PPUSA48, Calif. add tax. William Deane, 8831 Sovereign Rd., San Diego, Calif. 92123.

SELL TWO NEW PHILCO CLR-6 Microwave Repeaters $400.00—Tektronix Model 517 Oscilloscope with powed supply. Good condition. $275.00—Hewlett Packard Model 505B Electronic Tachometer Indicator. $40.00. Good condition. All above with manuals. Brice Benson, 2046 N. Adams, Indianapolis, Indiana 46218.

SELL: Telesig 301 transmitters, 302 receivers 42 cycle shift, with matching plugs and mercury polar relay. Make offer. No dealers. KL7OK/KH6, P.O. Box 291, Wahiawa, Hawaii 96786.

SB-300 & SB-400 $535. New condition with HS-24 speaker. W6TRU, 5226 Vickie Dr., San Diego, Calif. 92109 Phone, AC714-488-8673.

ITA COMMUNICATIONS SYSTEM, new. Built for FAA. Transmitter, receiver, solid state P.S., Harmonic filter, and remote control unit. Crystal controlled 118 to 152 Mc. 50 watts AM output. With instruction books. Paul Moffitt, W3HMR, 222 Sherbrook Blvd., Upper Darby, Pa. Call (215) CL9-4692.

GONSET GSB-6 SSB (6 meter transceiver) w/AC pwr sup. 2 Mo. old—w/manual, $295.00. NC-303 Converters, 220, 144, 50 Mc in matching cabinet, $75.00. W1VYB, 922-3850.

WANTED: Gonset 2 meter linear, II or III. W1VYB, 922-3850.

FRESNO HAMFEST, May 3-4-5 at the Tropicana Motel, 4061 N. Blackstone, Fresno, Calif. Tickets $8 until April 27th, include registration, banquet, etc. Send to Box 783, Fresno, Calif. 93721.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

GALVANOMETERS/METER RELAYS, New Weston #705, 0-10 microamps full scale or 5-0-5 microamps by shifting zero adjustment. $5.50 ea. Postpaid. Glen Richie, Box 26 Salem, Virginia 24153.

73

MAY 1968
60¢

AMATEUR RADIO

SPECIAL ANTENNA ISSUE

40M Diamond Array
New Gamma Match
Using Matching Stubs
Duo Vee Beam
Basic Antenna Theory
Triangular Loop Beams
IC RTTY Stunt Box
Computer Design of Beams

THE UFO NET

ADVANCED CLASS
STUDY COURSE
PART II

73 MAGAZINE

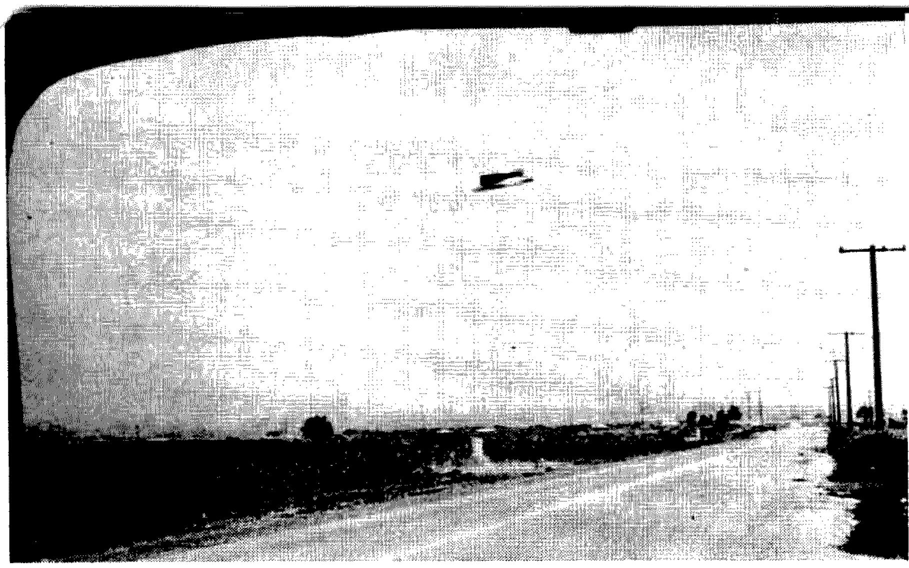
May 1968
Vol. XLVII No. 5

Departments

Wayne Green W2NSD/1
Publisher

Kayla Bloom W1EMV
Editor

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $12.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458. Say, don't read all this fine print. Get on to the articles, or better yet, send for our new DX Handbook.



This is one of three photos taken by Rex Heflin, an Orange County highway inspector, in August 1965. The UFO approached from the left, hovered over the road, moved right, hovered over the field, moved off and accelerated out of sight. The sighting lasted approximately 20 seconds. Helfin took this photo through the front windshield of his truck. This photograph is by courtesy of the National Investigations Committee on Aerial Phenomena, 1536 Connecticut Avenue, N.W., Washington, D.C. 20036.

THE UFO NET

Wayne Green W2NSD/1

Last month, in my editorial, I suggested the organization of an amateur radio network for reporting UFO contacts. This idea has met with widespread enthusiasm, I am happy to report.

There has to be a good reason for a network to exist if it is going to be successful. In this case amateur radio is probably the only medium that can help speed the solution of the UFO mystery. The basic problem is simple: Though there have been hundreds of thousands of sightings of UFO's, these contacts are usually of such a short duration that it is difficult or impossible to take adequate pictures or make any scientific investigations of the phenomena.

Amateur radio, by virtue of its ubiquity, can make it possible for advanced warning to be forwarded of approaching UFO's. This in turn can make it possible for pictures and scientific tests to be prepared, once the probable path of the UFO has been determined.

Amateurs who are interested in participating in this net should have an effective station set up on 80, 40 or 20 meters. I suggest the frequencies of 3900, 7250 and 14,250 kHz. The next step is to alert the local police that you are participating in the UFO network so that they will know to call you if anything is reported to their department. Then you should get in touch with every user of mobile radio in your vicinity and give them your phone number so they can notify you in case of a sighting. This can cover your local CB group, any amateur radio mobiles, taxis, doctors, vets, sheriff's departments, road crews, trucks, public service, forestry, etc. Give your card to the local newspapers and radio stations. They frequently are informed of UFO contacts first.

Once you have your community as informed as possible about calling you in case of a UFO report it is time to write a release to the paper and radio station telling them all about it so they can give you further publicity. This will be helpful to amateur radio too. We need all of the publicity we can get, as you know.

The UFO network will be rather informal at first. There are at present no fixed net control stations. We are interested in hearing from operators situated around the middle of the country who have very good signals and who have the interest and time available to help establish nets on the three major bands. In time I believe we will have a net that can be alerted anytime of the day or night, possibly with an alerting tone system. During the early phase of the net I suggest that we get together at 0000 GMT and discuss organization and plans.

The plans for the net have been discussed with the University of Colorado UFO inves-

(Continued on page 28)

Editorial Liberties

In 1939, the first foreign broadcast intruders invaded our 40 meter band. At that time ARRL assured us that their influence with the State Department would soon have our band clear again. The League gave it a good try, but unfortunately amateur radio was not strong enough to buck the invaders and today we have a multitude of foreign broadcast stations, not only on the 7 MHz band, but on other bands as well.

The international agreement on sharing the bands with broadcast stations is that they are welcome to use the amateur bands provided they do not cause undue interference. They *do* cause undue interference and still nothing can be done about it from the standpoint of ITU.

We ask how they can get away with this outrage. It is easy. Every time the question comes up as to their interference, they protest that they are *not* beaming their signals to the U.S. If you look at a schedule of Radio Moscow's broadcasts, they all say they are beaming toward the Scandinavian countries, or to Asia, or Africa. Never to the U.S. If this is true, why, pray tell me, are the broadcasts in English? And, why are they broadcast at the optimum hours for reception in the U.S.?

Their broadcasts scheduled for the Scandinavian countries are not only delivered in the English language, but, in most cases, at hours when they would be least likely to have a Scandinavian audience . . . like 0300 in Sweden. When it is 3 AM in Sweden, it is evening here in our hemisphere and the optimum hour for reception in the U.S. It becomes obvious to all but the ITU that they are covering their tracks by rather weak lies.

Our allies, the British, are little better, I'm sorry to say. Looking at their schedule one finds that the BBC broadcasts we hear in the evening hours here are intended for Australia. On *forty* Meters? C'mon, whom are they trying to kid? It's mid-day in Australia.

In case you haven't received the point so far, this editor is becoming annoyed by all this. Nearly thirty years of protesting has gained us nothing except more and more interference. And, in a way, we are to blame.

The amateurs of this country give the foreign broadcast stations a wide berth on all bands where they appear. We have, so far, made no effort to fight. We are much too willing to move to avoid the QRM, leaving the spectrum open to the invaders to use at will. Official protests obviously do no good, so we become resigned to our fate and allow the intruders to take over our bands. We give them an open invitation to take over more space by yielding our rights.

At some point or other there will be another frequency allocations conference and we will face the loss of frequencies. If we choose to ignore the foreign broadcast intruders, we could lose 40 meters. Once they can show that we are not using our allocated frequencies on that band, they will have a good case to take over from us. If you are willing to have them do that, fine, but don't scream when it happens. The time to begin fighting has long since passed, but perhaps we can put up a battle even now.

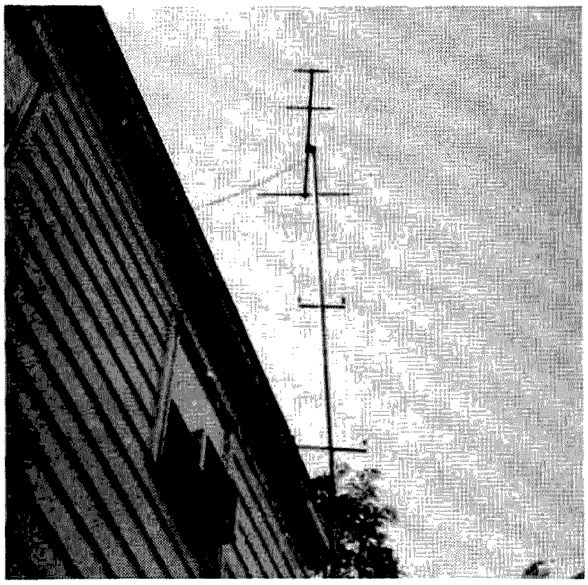
These broadcasts are all on AM. Ask any AM station what happens when a solid SSB signal comes close to the frequency. Copy is difficult at best. This works both ways, I grant you, but AM suffers more from SSB interference than SSB does from AM interference. A few strong SSB signals using a frequency which is just off zero beat from the foreign broadcast station's signal could create sufficient QRM that the listeners, with rather unsophistocated receivers, would cease their listening and thereby defeat the purpose of the broadcasts.

Don't think for one moment that this would be illegal. They, not we, are the intruders. By international agreement, we have the right to use 40 meters exclusively for amateur radio.

If some night you found yourself awakened by the sound of someone invading your property, would you wait until he had gained entrance to the house? Or, would you meet him at the gate and try to prevent him from invading the house where you keep your valuable possessions? Let's meet them at the gate and stop them before they gain entrance to our valuable frequencies. Fight the QRM with the knowledge that you are giving them just as much trouble as they are giving you.

. . . W1EMV

Practical Miniature Antennas For 80 Through 10 Meters



Robert L. Gilmer W8VVT
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Portsmouth, Ohio

Equipment miniaturization has become common-place in Amateur Radio with the advent of modern transceivers and kilowatt linears that can fit in a shoe box. This article carries the miniaturization idea one step further, however, and describes *antennas* that are only 1/20th conventional size and, amazingly enough, have almost imperceptable losses, — 1 1/2 dB, compared with full size half waves.

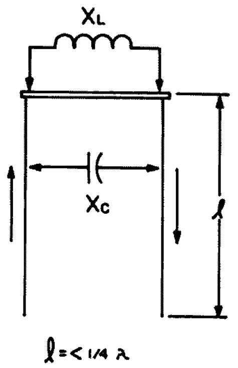

Fig. 1. The inductive reactance of a short copper element and the capacitive reactance of a $1/4\lambda$ section of open-wire line are combined to form a resonant antenna system.

Theory

The theory involved is quite simple: The *inductive* reactance of a short copper element and the capacitive reactance of a 1/4 λ section of open wire line are combined to form a resonant antenna system. **See Fig. 1.**

Since the open-wire line carries currents 180° out of phase and the wires are separated by only .024λ, there is very little radiation from this section. All radiation, therefore, takes place from the short copper element.

Losses

Reducing the size of an element lowers the radiation resistance considerably. An element only .024λ long, the length used here, shows a radiation resistance of only 0.5 Ω. However, the efficiency of the radiator remains better than 98% since the ohmic resistance of the short 3/4 inch copper elements average less than 0.008 Ω. I^2R losses in the open-wire line section are shown graphically in **Fig. 2.** If the line is made of at least #16 wire, the losses are small averaging slightly over −1 db.

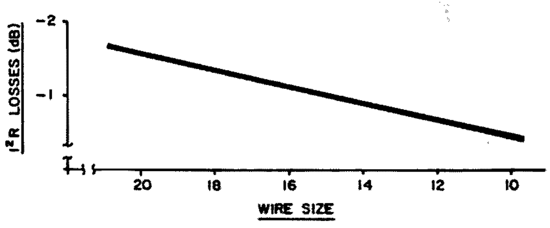

Fig. 2. Short antenna average I^2R losses vs. line wire size.

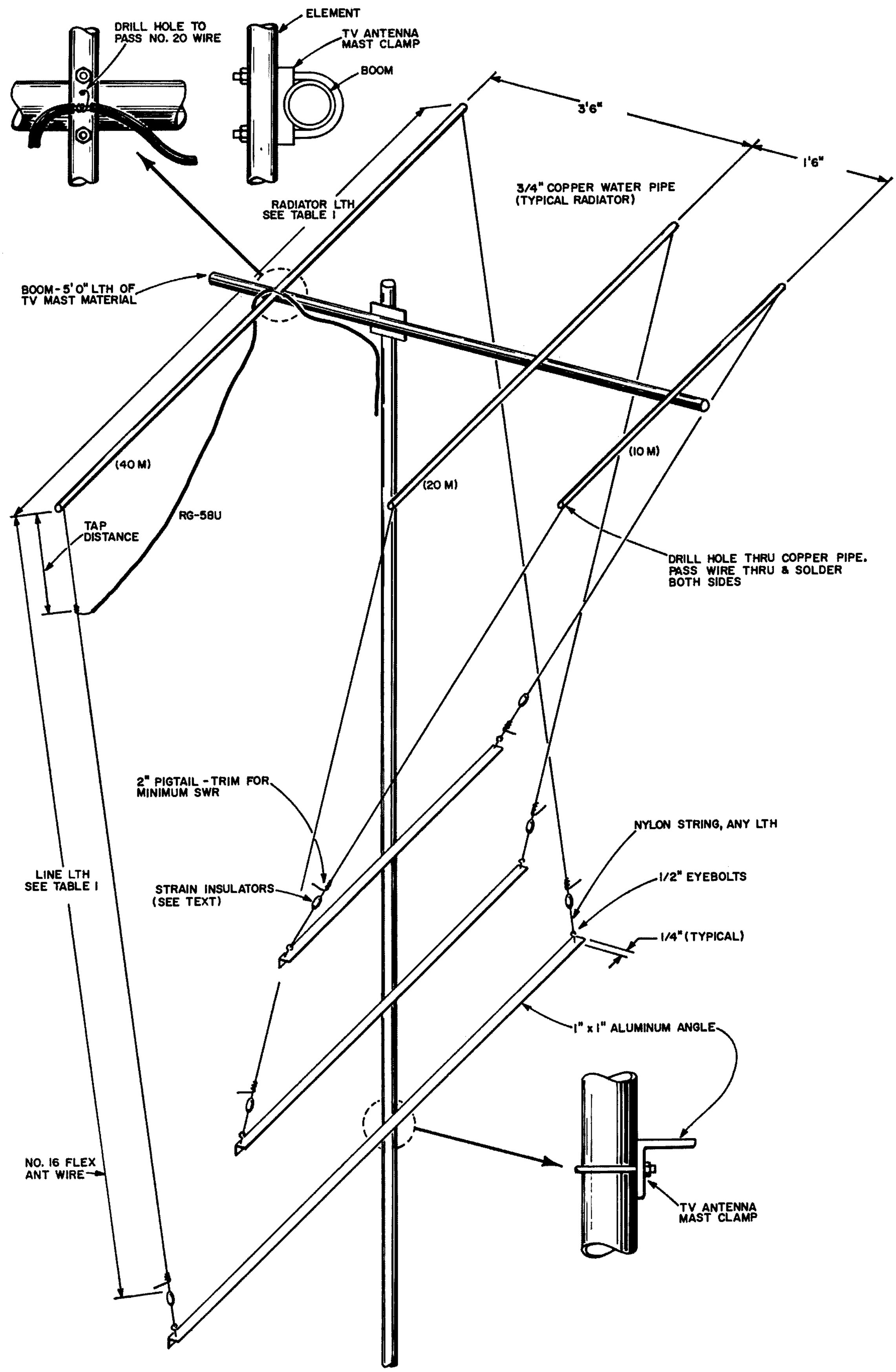

Fig. 4. Construction Details

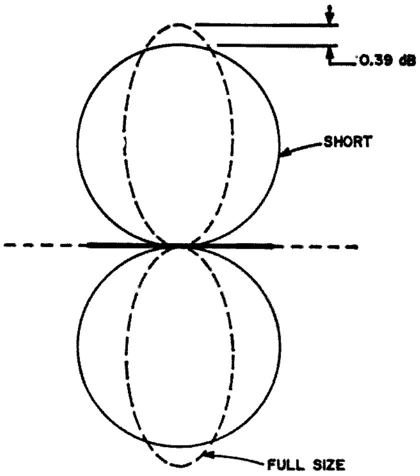

Fig. 3. Field pattern comparison short vs. full size element.

In addition to the I^2R (heat) losses in the element and line outlined above, there is an additional loss, termed the directivity loss, that results from shortening the radiator. This is illustrated in **Fig. 3.** The radiation from a full size half-wave element forms the classic figure eight pattern. However, as the length of the element is made smaller and smaller the ovals of the eight become more nearly circular although the general radiation pattern remains the same. The result is a loss in the immediate forward direction of −0.39 dB, and some "filling out" along the sides.

Summarizing: The directivity plus I^2R losses in these short element antennas average −1 1/2 db when compared with full size elements, a loss that could hardly be detected in the received signal!

Construction

Table 1 includes all the information required to size antennas for 10 through 80 meters. **Fig. 4** shows suggested construction details.

Additional Construction Notes

Horizontal arrangements are shown, although, vertical polarization could be used just as well.

Individual coaxial feeds are used on each band; however, one could design a parallel single feed that would function with very little additional loss.

Tap distances for use with 52 Ω coax are shown; however, feed lines of any impedance, balanced or unbalanced, can be used by merely tapping down on the line. Series capacitors are not required since the system is resonant and a purely resistive load is offered to the feed line.

Good quality moisture resistant end insulators should be used since extremely high r.f. voltages appear at this point. High impedances and higher voltages are the effects of standing waves on the open-wire line.

Because the capacitive reactance (of the 1/4 λ line section) changes rapidly with frequency, the tuning of the line is quite sharp. The dimensions given in the table, if followed closely, will place the resonant point of the antenna at the *lower* end of the respective band. The construction details show short pig-tails on each side of the line. These should be trimmed one-quarter inch at a time until the SWR is 1:1 at the operating frequency.

Table 1

Band	Length Radiator	Line[1]	Tap[2]	B.W.[3]	Loss[4]
10M	10"	8'3½"	3"	245 Kc.	−1.3 db
15M	15"	11'1½"	4"	215 Kc.	−1.4 db
20M	20"	16'8½"	4½"	140 Kc.	−1.5 db
40M	40"	33'1"	7"	80 Kc.	−1.7 db
80M	80"	62'10"	12"	50 Kc.	−2.0 db

Notes: (1) Adjust line length for SWR 1:1 (see text)
(2) 52 Ω tap
(3) Bandwidth at SWR 2:1
(4) Includes line I^2R losses and 0.39 db directivity loss. #16 line wire size assumed.

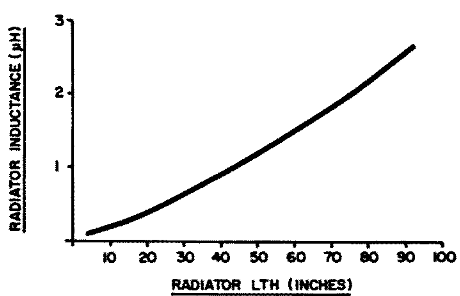

Fig. 5. Radiator length vs. inductance.

Design Details

The inductance, L_R, of short lengths of 3/4 inch copper pipe is shown graphically in **Fig. 5.** The inductive reactance, X_R, may then be calculated from:

$$X_R = 2\pi f_{mc} L_R$$

The length of open-wire line, l° (degrees), required to furnish the necessary

resonant capacitive reactance can be determined from:

$$\text{Cot } 1° = \frac{X_R}{Z_o}$$

The line impedance, Z_O, for various spacings is shown in **Fig. 6.**

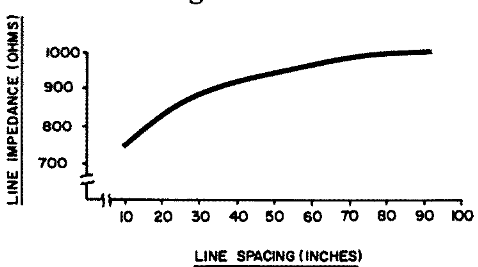

Fig. 6. Line spacing vs. impedance, Z_o, wire size #16.

Results

Tap distances, antenna "Q", and bandwidths were first calculated and then substantiated by testing. Unfortunately efficiencies were calculated but, lacking facilities to do so, were not checked under operating conditions.

Antennas for each of the bands have been constructed and used with results comparable to any of the full half waves used here at various times. Comparisons were run against a long wire (275 feet) antenna by switching between the two. In the direction of the maximum lobe of the long wire, the long wire outperformed the miniatures by 1/2 to 2 S units. In all other directions the miniatures were equal to or better than the longer wire. Both coasts are worked regularly on 40, 20 and 15 with reports ranging from S5 to S9.

Conclusions

Where space is available to mount them, full half waves have the edge, but if not, substitution of the minatures probably will not affect the results one way or the other, and then, you just might be able to raise the minature higher and that's a lot more effective than increasing it's length.

References

Radio Engineering Handbook—Terman, McGraw-Hill Publisher.

Electromagnetic Waves and Radiating Systems—E. C. Jordan, Prentice-Hall Publisher.

"Miniaturized Antennas"—J. J. Schultz, W2EEY/1, CQ November 1967.

The Diamond Array

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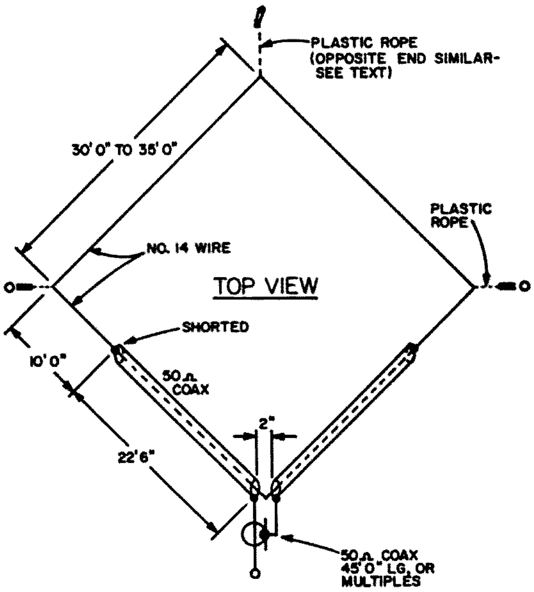
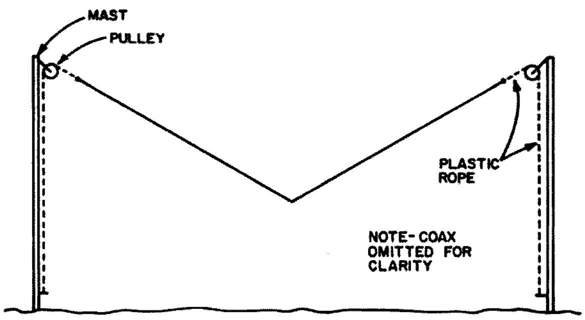


This efficient little antenna features several popular designs all in one. It is one element of a 40 meter quad-one full wave length in a diamond or square, two upright Vee antennas fed in phase, an upright Vee derived from the design of the familiar co-ax dipole, and it has a gain of 3½ or 4 dB over a standard dipole. It is rather broad in frequency response, and non-directional.

The antenna can be oriented 90 degrees, that is, fed from one of the high angles, with no noticeable change in performance. However, by using one of the low angles for the feed-point, it may be possible to keep the feedline away from the field of the antenna, and also even use a more direct feed to the rig.

Plastic or glass lines are used for support and are run thru pulleys for ease of erection and tuning. The lengths of the single wire on the opposite Vee from the co-ax fed half of the array is not critical, but the actual tuning for best SWR and frequency of the antenna is done with the 10 foot ends of this first co-ax half.



The two low opposite angles are pulled down and out to supports at each side of the lot, resulting in approximately 20 feet above ground for these angles. The opposite high angles of the diamond are around 45 to 50 feet high.

The far end of each half of the dipole co-ax section is shorted, with the single wire extending around the diamond from these points. The 50 ohm co-ax shielding only is opened up for 2 to 3 inches and the feedline connected at each section of shielding. This folded dipole effect gives the design a good flat SWR throughout the band. To reduce the strain at the feedpoint, a short bridle or yoke of plastic or glass line is wrapped around each side of the co-ax and tightly taped with the tie-line brought out from this spot.

In tuning for the best SWR or for the best center frequency, always use an SWR meter with an exciter for low power—100 watts is ample.

If the low frequency end of the band shows the best SWR, or it results in an increasingly better reading although still far from 2 to 1 or better, the single wire section is too long, and a foot should be cut off from each end of the 10 ft. extensions. The SWR reading then should be checked and if improvement is noted—continue cutting and testing until satisfaction is reached or the tuning is correct.

Now, should the SWR show improvement by tuning towards the high end of the frequency of the 40 meter band, and still in excess of what it should be, the antenna is too short. At least a foot or more should be added to each single wire end for the next check point on the SWR.

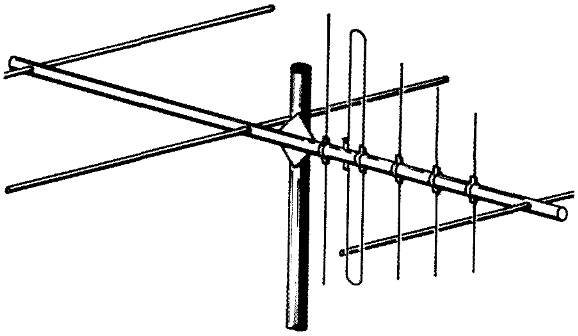
No balun is necessary, just keep your co-ax feed in the clear and away from grounds.

The writer's SWR figures were as follows:

7.3 mc—2 to 1
7.2 mc—1.25 to 1
7.1 mc—1.05 to 1
7. mc—1.22 to 1

In closing, much to the amazement of this amateur, very good SWR is obtained both on 20 and 10 meters. So, if you like to try out antennas, here is one that may surprise you.

. . . W6LNN



Why Not?

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In the course of human events, one sometimes finds necessity the mother of invention. Since my low frequency beam had to come down for some adjustments, I begun wondering why one piece of equipment couldn't serve two functions. Since the beam usually occupies the tallest tower and located in the most favorable position, why not use it for a VHF platform, so to speak. The idea is simple, have the boom for the HF beam also serve as the boom for a VHF antenna. This works out well, especially where VHF is vertically polarized as it is here in California. There is virtually no interaction between the two beams.

To avoid drilling the boom, and thus weakening it, I used clamps to mount the VHF elements. The most convenient and readily available clamps are the strap type which are used to hold electrical conduit in place. However, you could use any similar arrangement; i.e. plumbers tape, U bolts, etc.

Construction is simple. The elements can be lightweight aluminum tubing with the ends flattened, or aluminum clothesline bent to fit the clamp on one end.

A supply of clamps, slightly smaller than the diameter of the boom are produced or fashioned. The elements are then cut to half their length (this being determined by any good antenna handbook) minus the diameter of the boom clamp. The elements are then drilled to take the clamp screw or bent to take the clamp screw if aluminum wire is used.

A top and bottom element are then fastened together, using two boom clamps for clamping the element to the boom. This leaves half the element above, and half the element below the boom.

The driven element is fastened much the same way, but at this location a folded dipole element is used. The feed point being brought to stand-off insulators on the boom and fed at this point either through a balun or using twin lead.

After proper spacing of the elements for best front-to-back, or forward gain, it was found that there is very little interaction between the two beams. There was less than ½ volt measured across the VHF lead when transmitting on the HF beam. This can be bled off with the use of a grounding switch or a simple diode placed across the feed line.

. . . W6HGX

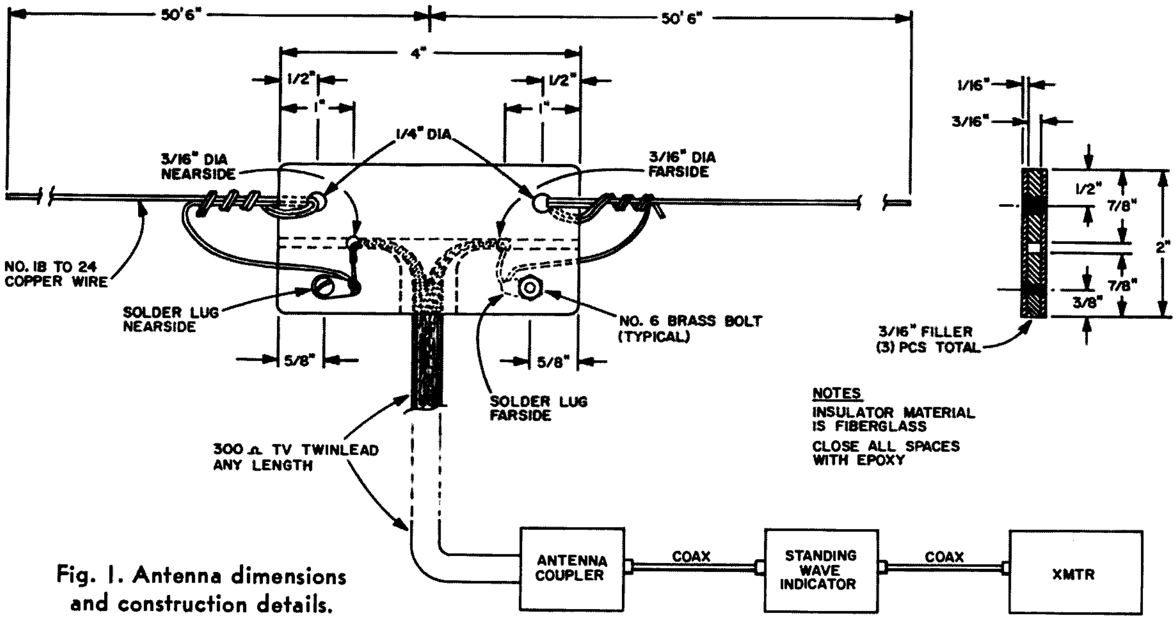

Fig. 1. Antenna dimensions and construction details.

Do It With a Wire

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It seems to be the proper thing these days for every ham to get with it and build something. Few people get any pleasure out of spending long, lonesome hours in the basement following someone's dull instructions on how to assemble a piece of equipment which could be bought outright for the same price. Then too, lots of people do not have the tools or test equipment to pull the job off effectively. However, there is one thing that just about every ham can homebrew and have a fine time doing it. That thing is an antenna. There is no more pleasant way to become a member of the elite homebrew set, than spending a sunny afternoon tramping around the back yard doing antenna work. It is even better if you are lucky enough to have a couple of trees to climb. You will be surprised at the fine view about fifteen feet up, and you have a ready adult answer for the neighbor's kid when he comes out, "Hey, mister, what are you doing up there?"

So, let us get started stringing one up which is a little different, and a bit better, than one you can buy. I have found that two very important things about antennas must be kept in mind if you want to have a pleasant experience when experimenting with them. First, contrary to popular opinion, they work according to the book. Second, any length of wire that is no shorter than a quarter wave length, can be center fed with 300 ohm TV twin lead, and be matched to a coaxial cable with an ordinary antenna coupler. Not only will it load, but it will operate with good efficiency and can handle powers up to 600 watts. The antenna I am about to describe, makes use of these important facts.

The radiation pattern of a simple single wire antenna will generally be as described in all antenna books. So, if it is a half wave long the maximum radiation will be at right angles to the wire. If it is a full wave in length, and center fed, it becomes a double Zepp and the maximum radiation is still at right angles to the wire. The antenna problem we are striving to solve is how, by using one wire, can we radiate East and West to cover the United States, and Northeast and Southeast to cover Europe and South America, with good efficiency. By carefully studying the radiation patterns of many lengths of antennas we find that a long wire antenna for twenty meter operation would be just the thing to cover Europe and South America. If it was made a wave and a half long it could

be fed at the center current loop; be run North and South and have a fine East-West pattern when used for the forty and eighty meter bands. When excited with a twenty meter signal, here on the East Coast, one of its main lobes will cover Europe, and another South America. We do not have to be concerned about its impedance because we are going to use a tuned transmission line (TV twin lead) and an antenna coupler. Feeding it in the center will make adjustment of the coupler simple and broad enough to cover a large segment of each band without retuning. When it is used on twenty meters, a gain of .8 dB over a dipole and 3.8 dB over a vertical is realized. Also, its cone shaped pattern off the ends makes it less sensitive to height for low vertical radiation angles. This antenna was cut and strung North and South at a height of about 22 feet. Tests proved that it operated just as planned and out performed my vertical on every occasion. It also made a surprisingly neat appearance.

As shown in **Fig. 1**, the antenna is 50 feet 6 inches long on each side of the feed line. The twin lead can be any length, and seems to be lossless for all practical purposes. For parallel tuning on all three bands, it should be 73 feet long. **Fig. 1** also shows the construction details of the center insulator and feed line connector. It is made of circuit board material, preferably fiber glass, because of its strength. The three fillers and two outer plates are cemented together with epoxy to make sure it is sealed against the weather. The one hole in each outer plate is drilled before assembly. The holes for the antenna wire and solder lugs are drilled after the epoxy cement has hardened. Before passing the antenna wire through the insulator, bend it double about ten inches from the end. After it is through, wrap the doubled portion neatly around itself for about a inch. This will leave enough of the single conductor end to loosely bend back and solder to the lug along with the twin lead wire. The insulators at the extremes should be at least four inches long.

Details of the antenna coupler adjustments can not be given, because each type will have to be used according to its own operating instructions. There is one help that I always use. That is to connect one terminal of a NE51 neon bulb to one side of the twin lead at the couplet output. The bulb

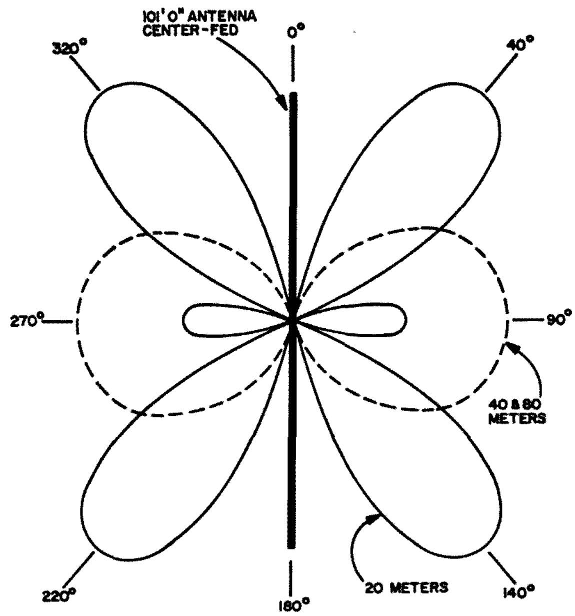

Fig. 2. Free Space horizontal pattern.

will glow if the glass part is near the case of the coupler and give a good indication of the amount of rf at its output. Keeping one eye on the standing wave indicator and the other on the bulb will prevent you from adjusting to a false standing wave indicator null.

Now a word to the ham who has an inquisitive nature and would like to do a little experimenting. There is no reason why this antenna can not be used for the ten and fifteen meter bands, in fact, its gain will be improved as the frequency gets higher. If the twenty meter band is your only interest, it can be fed with 75 ohm coaxial cable instead of TV twin lead eliminating the need for the coupler. You will have to carefully cut the antenna for the lowest VSWR in order to compensate for its surroundings, but after completed, its pattern will be the same as with the twin lead. **Fig. 2** shows the free space antenna pattern when excited with a twenty meter signal. All kinds of interesting results can be obtained by tilting the wire. This will tend to move the top part of the main lobe parallel to the ground, giving a very low angle of radiation. The lower angle will bounce your signal a little further.

The materials used for constructing this antenna are very strong, but light weight. This permits the assembly to be held in temporary positions with heavy fishing line for experimenting or permanently fastened strongly to withstand the heaviest weather.

. . . K3QKO

A Durable New Gamma-Match

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The subject is a **sturdy** gamma match with a one piece gamma rod. It can be made inexpensively from scrap metal and discarded parts. The gamma rod, labelled **A** in **Fig.** 1, is a piece of 50 ohm foamflex aluminum shielded coax. No more than 3 feet is required for 20, 15, or 10 meter beams, and a piece this size can usually be picked up gratis from most any two-way radio store. The SO 239 coax connector, **B**, is joined to the center of the driven element by an alunimum strap, **C**. At this QTH the aluminum was obtained from the scrap barrel at a local machine shop, gratis of course. At an arbitrary length from **B** a second aluminum strap **D** was placed which acts as the shorting bar. The distance, **d**, between the driven element of the beam and the gamma rod should be at least 3 inches or else the gamma rod will be inconvienently long.

The following steps were necessary in adjusting the gamma match:

1. First, the ends of the aluminum shielding next to the coax connector end of the gamma rod were bent outward slightly, and a coat of good sealer was applied for weather protection. The inner conductor of the coax was not connected to the SO-239 but was left floating, and a 100 $\mu\mu F$ variable capacitor wired between the aluminum shielding and the coax connector as shown in the inset of **Fig. 1.**

2. The beam was taken up the tower to a height near that to be used in the final installation, as settings made near the ground will not be valid at normal operating heights. A signal was then fed to the beam from the transmitter, and the shorting bar and variable capacitor varied simultaneously until the setting with minimum SWR was determined. A Heathkit Reflected Power Meter and SWR Bridge was used for this operation. The shorting bar was fixed at this point.

3. The variable capacitor was brought down very carefully without disturbing the setting so that the capacitance could be measured with a capacity meter.

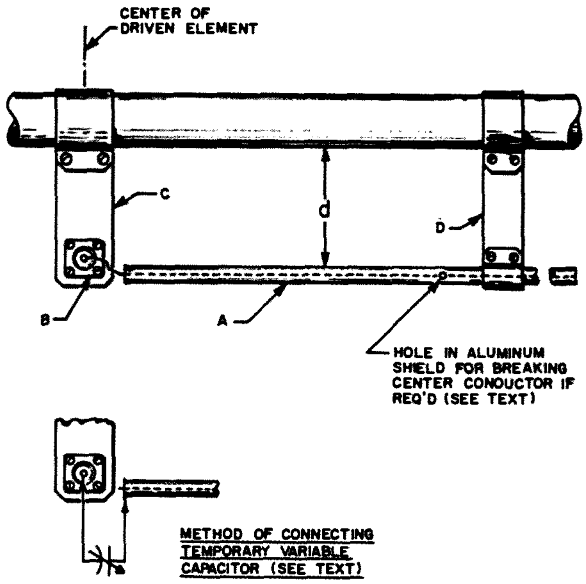

Fig. 1. The essential features of the gamma-match.

4. At this juncture knowledge of the capacitance per foot of the foamflex was necessary in order to use the proper length to equal the capacitance from the variable capacitor. Our material was known to have a capacitance of 29 $\mu\mu F$/foot, and an appropriate distance was measured. If the distance falls beyond the shorting bar the coax can be cut at this point as shown by the diagonal line in **Fig. 1.** If it falls inside the shorting bar, as was the case for our installation, a hole must be drilled into the foamflex breaking the inner conductor as shown by the circle-dot on **Fig. 1.** The hole was subsequently filled with sealing compound to insulate and weatherproof.

A gamma match constructed in this manner was used on the 15 meter beam made by converting a TA-33Jr. as described in an earlier issue of this magazine. In the past 20 months it has been fixed at a height of 73 feet and has endured sustained winds of over 60 MPH in brushes with 3 hurricanes.

No damage or malfunction has resulted and consequently we recommend it to you.

. . . K4IIF & K4ELB

How to Hang a Dipole

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If you're a beginning ham operator or SWL, why don't you try a twinlead dipole? It offers good performance from a design practically as simple as a random long-wire antenna, but without the longwire's grounding problems. Its relatively narrow-band performance is usually no inconvenience. And it can be tuned up without a transmitter or SWR bridge. TVI problems become less severe because the transmitter rf, provided with a good place to go, loses interest in house wiring and TV sets.

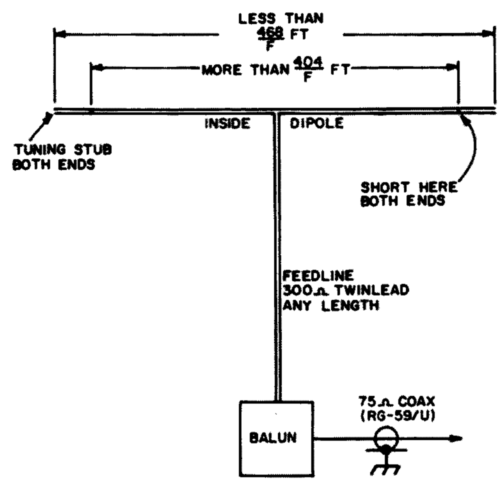

Fig. 1. This is the complete antenna system you're going to build.

The twinlead dipole

Two pieces of 300-ohm twinlead will make a very fine folded dipole, usable for receiving and low power transmitting applications. One piece is to cut slightly under a half-wave length at the operating frequency and hung parallel to the ground. The other piece is attached to its center to serve as feedline, as shown in **Fig. 1.** The feedline may be any convenient length.

The 300-ohm antenna and feedline inpedances are properties of the folded dipole kind of antenna. The 300-ohm twinlead was designed to meet this special requirement. "300 ohms" means that, as with dc, if you apply 300 volts you will find 1 amp flowing. But unlike dc, this applies only at the antenna's resonant frequency. If you replaced the 300-ohm feedline with 75 or 450 ohm twinlead, you'd end up with a mismatch, not a new antenna system.

Many radio receivers will take 300 ohm balanced or 75 ohm unbalanced input, but most amateur transmitters are designed to feed a 75 ohm load. These two load systems cannot be connected directly one to the other, but a transformer or an electrical circuit which seems to act like a transformer may be used as an almost perfectly efficient adapter. From the unwieldy term "balanced-to-unbalanced" we have the modern word "balun."

Three types of balun are used in most amateur work. All are equally appropriate for transmitting and receiving, if they are heavy enough to handle the transmitter's powerful rf. They are the toroidal transformer, the interwound coil, and the coaxial cable varieties. Only the coaxial cable balun, shown in **Fig. 2,** requires tuning.

If you don't already have a balun, the easiest and least expensive way to get one is to make it from coax cable. The exact length of cable required depends upon how fast the rf travels through it, so, if the balun is made up from a piece of coax perhaps 5% too long, you can use the haywire bridge described later to zero in on the proper dimensions. This eliminates difficulties with a piece of cable whose specs may not be quite right.

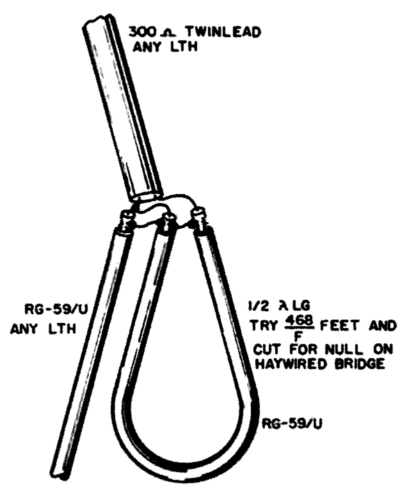

Fig. 2. This coax balun is about as simple as you can get. Avoid shorting between center and outer conductors!

The dipole's "radiation pattern" is which way the rf goes once it leaves the dipole. For receiving purposes, efficiency is best in the directions that get the most rf when transmitting. The dipole's radiation pattern varies sharply with height above ground, and the highest possible installation is not necessarily the best. **Fig. 3** shows the striking variations in radiation pattern as the dipole's height is increased from 0.2 wavelengths above ground to 0.5 wavelengths. If you cannot achieve either of these altitudes, simply try for the clearest possible location.

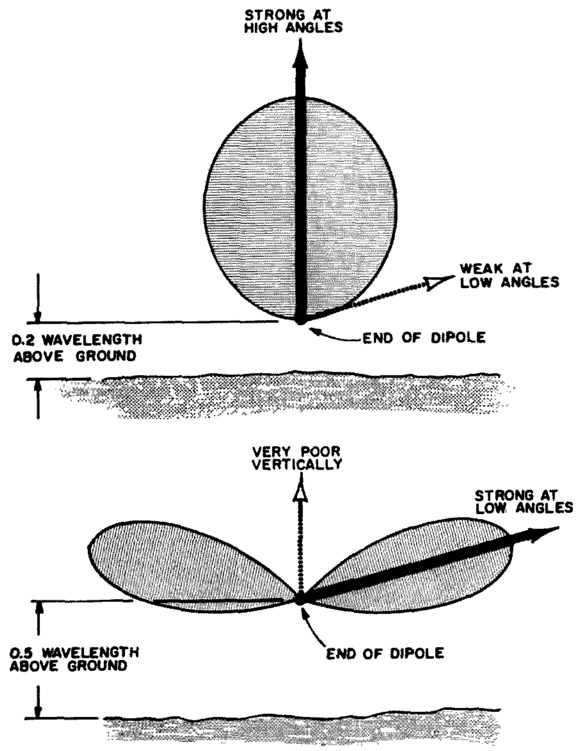

Fig. 3. The dipole has two basic radiation patterns. Here they are, as seen from the dipole's end.

The dipole's electrical properties also depend upon distance from ground. **Fig. 4** shows how the input resistance varies with height. For best results try for some height near one giving a 300-ohm input resistance.

Although the dipole is said to show zero response or radiation off it's ends, quite good signal reports may be obtained in these directions. This is because the dipole really does radiate off its ends, but only steeply up into the sky. Signals in these directions would be improved with a second better-oriented dipole. Well, why not?

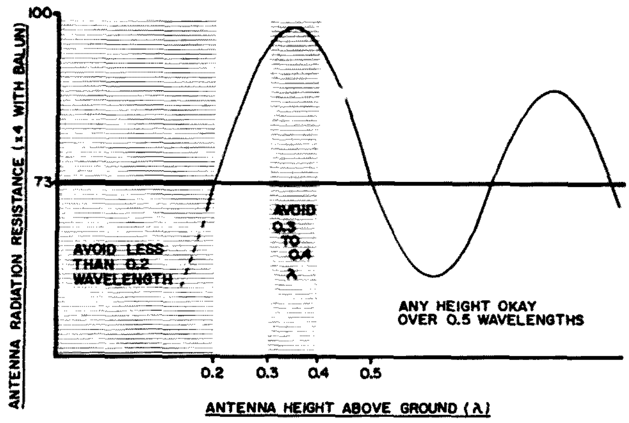

Fig. 4. The dipole's input characteristics depend upon height. Here are the two important numbers again: 0.2 and 0.5 wavelengths.

Putting up the dipole

Read everything you can find on dipoles of any variety. Then work out a way to get the twin-lead version into the air, and if you cannot meet all the specs put it up anyway. A cut-and-try test session will probably zero things in quite well.

Trees, drain pipes, lightning rod systems, towers, and what have you will all affect the folded dipole. The usual result is a measured resonant frequency lower than calculated. The dipole seems a little too long. And various nearby structures may also electrically unbalance the dipole.

Suppose L is in feet and F is the operating frequency in MHz. Cut a strip of twin-lead at least 404/F feet long, short both ends and attach the feedline to its center. Add tuning stubs to each end, both stubs equally long, for a total length of 462/F to 468/F feet. The twinlead makes good stubs. The dipole minus stubs is too short,

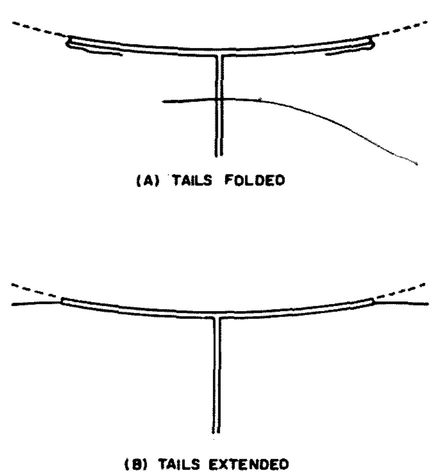

Fig. 5. How the tuning stubs are placed for highest (A) and lowest (B) resonant freqency.

with stubs fully extended is too long. See **Fig. 5.** By folding the stubs back, you can tune or retune the dipole to frequency, and balance out uneven effects of nearby structures.

Assemble the antenna in any convenient way similar to the handbook and magazine descriptions. Nylon line will do a fine job and you can omit the insulators for low power. Seal twinlead openings and splices, since moisture leakage may change the twinlead characteristics or corrode the wire. Tie the tuning stubs back against the dipole as shown in **Fig. 5A** and pull it up into the air.

Testing and tuning the dipole

With the twinlead dipole in place and the transmission line strung to the vicinity of the receiver or rig, everything that could affect its tuning or input characteristics has come into the picture. We know it will resonate near but above the correct frequency, and we know that we've done all we can to get the best input impedance. Now we do some testing.

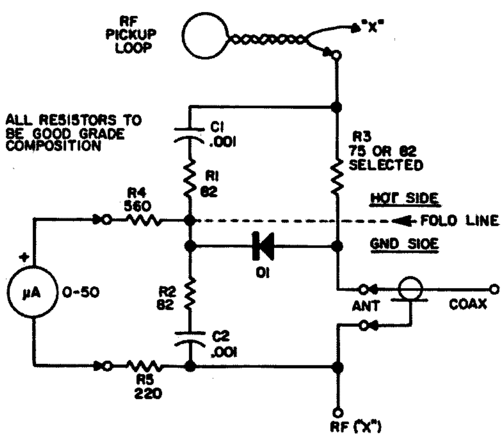

Fig. 6. Schematic of the haywire test bridge.

We compare the dipole with a resistor at various frequencies, and specially note the frequency which gives the best similarity. The haywire bridge shown in **Fig. 6** does this.

It's a simple Wheatstone bridge with a diode detector. Let's suppose that the antenna terminal has a 75 or 82 ohm composition resistor across it, the same value as R3. Then the LH and the RH component strings are 2:1 voltage dividers, points A and B see the same rf voltage, in phase, and there is no dc fed to the meter.

If the antenna resistance is replaced by any other value, or if inductive or capacitive reactance is added, the balance is disturbed and we see a meter reading. This circuit tells us when the antenna terminals look most like a resistor, which is enough to get by. There is more to this, which you should look up later, but for now: simple problem, simple answer.

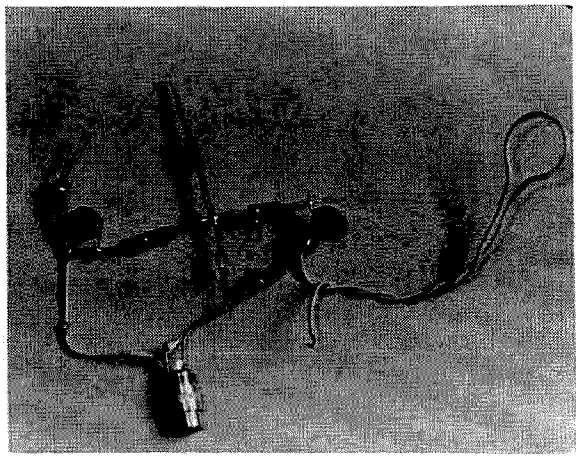

Fig. 7. This is what the haywire bridge looks like just before folding over.

The bridge circuit will give the best results if it is built of properly chosen components. Capacitors C1 and C2 are not critical, but should measure the same value on a capacitor tester. R1 and R2 are also ballpark accuracy if they measure the same on an ohmmeter. R4 and R5 are uncritical isolating resistors. Choose a good new resistor for R3. All resistors should be composition variety. D1 is any known good germanium rf diode.

Assemble the parts with short leads in the relative positions of **Fig. 6.** This should come out resembling **Fig. 7.** Then fold the entire assembly, like a book, around the diode, bring the two outside rf points together, and solder them to the rf input line. If you're using a signal generator, the ground site of the bridge goes to the generator's ground. Clip in the meter, and you're nearly ready to test your antenna. But first, test the bridge!

Feed enough rf into the bridge to bring

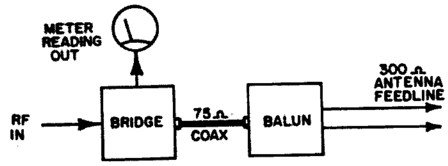

Fig. 8. Block diagram of the antenna test setup. A signal generator could replace the GDO. See how this fits into Fig. 1.

the meter to full-scale with an open circuit across the antenna terminals. That's what is happening in **Fig. 9.** Without changing anything, place a resistor equal to R3 across the antenna terminals, and the meter reading should go very close to zero. It should stay there independently of large changes of rf frequency.

Once you know the haywire bridge works properly you may want to attach it to the complete antenna system. Don't do that! Is your balun in good order? Connect a 300 or 330 ohm composition resistor across the balun's twinlead side, set up the bridge, and check for drop from full meter deflection to near zero. If you are using a coax balun, the null will be frequency dependent and belongs on your chosen operating frequency. Double check by finding the signal on your receiver.

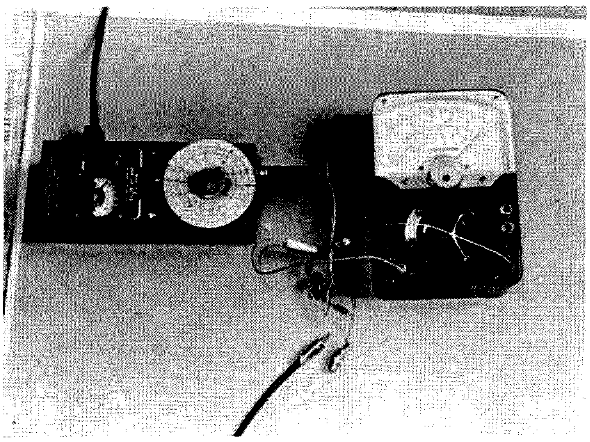

Fig. 9. Here's the haywire bridge, just before connecting the antenna. RCA connectors are handy, or use anything on hand.

Now you can test your antenna. As before, adjust rf source and bridge for full scale deflection, attach balun and antenna, and find the best null frequency. Repeat the test with the stubs fully extended, to find the lowest operating frequency. Your target frequency should be between these extremes.

By shortening the stubs and checking null or resonant frequency, you can quickly zero in on the antenna tuning you want. If you cut the stubs they're hard to lengthen, but folding and taping has the same effect. If the null is not sharp and deep, try raising, lowering, and unbalancing the antenna. Make one change at a time and keep a record of results.

When your new dipole is in the air it's likely to look different from the handbook

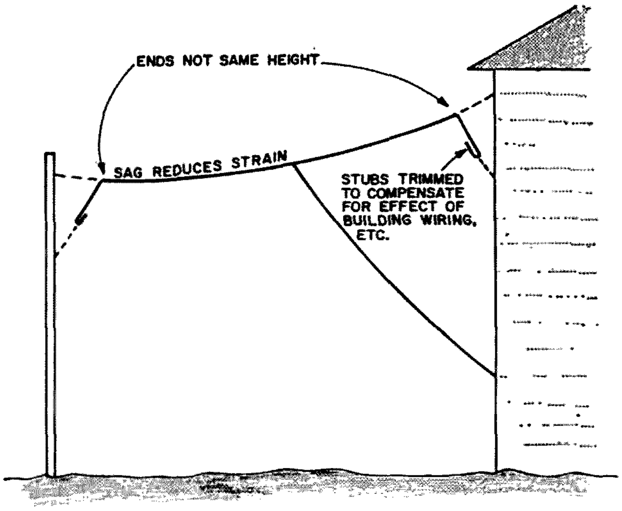

Fig. 10. Your finished antenna might look something like this. A little uneven, but tested right.

sketches. See **Fig. 10.** The sag reduces load on supports. The trim stubs are pulled off to the sides to guarantee their location and to improve their influence upon tuning. The floppy cords that are probably hanging around should be secured in place so you can find them next time they're needed.

All this does sound like a lot of hauling, but it's productive work because you know how to end up with a workable result. You'd have to do it anyway if you found that your antenna was mistuned. If you've never tested your dipole and it flunks this simple test, you may be quite surprised at how much livelier the band becomes. I know I was!

. . . W2DXH

Matching Stubs

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This article will show you how to match any feedline to an antenna and get an SWR of less than 2 to 1. There is no restriction on antenna type or feeder length. All that is required is an SWR meter; however, knowing the approximate antenna impedance will do.

First, I'll tell you how I came across this idea. I had just moved and no longer had any good trees for stringing up antennas. I looked through some old *73's* and came up with a bi-square antenna. It looks like a single element from a Quad, except that it is a half-wavelength long on each side. The article (73, August 1961) was by David Bell W8GUE/6. Many thanks to David for an excellent antenna.

There was only one small problem. My version was for 15 meters with each side about 22-feet long. This made it more than 30-feet tall when suspended from the peak. In the article it was matched through a quarter-wave stub of open wire line hanging from the end. This was another 11 feet added to the end. My only tree was not tall enough to accomodate this too. The bottom three feet of the stub were left on the ground. In addition, I was going to have to tune the thing by the trial and error method after I got it up. I figured there had to be an easier way to match all this junk up so it would radiate properly.

A few hours spent flipping through the pages of the ARRL *Antenna Handbook* and other books were very profitable.

When a line is hooked up to an antenna and the impedance of the line is different from that of the antenna, then there is a reactive component present on the line. The SWR is high and losses increase. A great deal of power may be lost without putting much of a signal on the air. To rectify this you need only put in an equal amount of reactance, but of the opposite kind. This will reduce the SWR and power losses.

A length of transmission line which is a quarter-wavelength long behaves like a resonant circuit. If it is shorted at one end, it appears as a parallel resonant circuit with high resistance; if open-ended, a series resonant circuit with low resistance. Lines

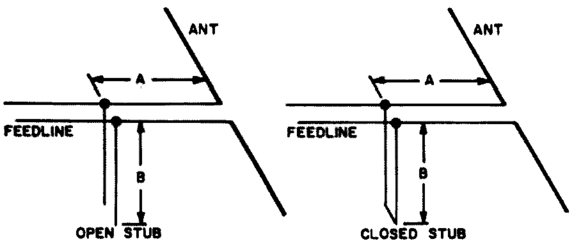

Fig. 1. How reactance is inserted. A shows the distance from the antenna for inserting the stub and B is the length of the stub.

shorter than a quarter-wavelength will exhibit reactance as well as resistance. An open end line will have capacitive reactance. A closed end line will have inductive reactance. A line less than a quarter-wavelength long may therefore be used to match antenna and line impedances for low SWR.

Fig. I shows how the reactance is inserted. *A* is the distance from the antenna at which the stub is inserted. *B* is the length of the stub itself. **Fig.** 2 shows another arrangement which performs the same way, but looks a little different.

If either the standing wave ratio or the impedance of the antenna is known, then lengths *A* and *B* can be computed easily. There are only two requirements. One, the stub and the feedline must have the same impedance, and two, the antenna must be resonant at the intended frequency of operation. These are easy requirements to fulfill.

The first decision to make is whether to use an open-end stub or a closed stub. This will depend on the ratio of antenna to line impedance. When the antenna impedance is

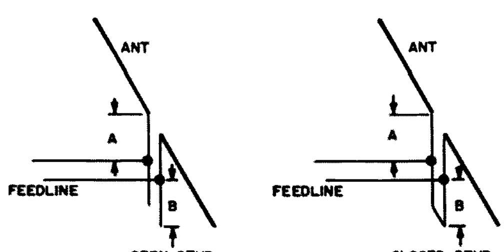

Fig. 2. This arrangement gives the same performance as Fig. I but is different in appearance.

less than the line impedance, a capacitive or open end stub is used. If the antenna impedance is greater than the characteristic line impedance, an inductive or closed end stub is needed. If you are using 150, 300, 450, or 600 ohm twinlead or ladderline and the antenna is current-fed, then you will probably need an open stub. If the antenna is voltage-fed, then a closed stub will probably be needed. There are exceptions.

Fig. 3 shows the current and voltage distribution along a half-wavelength of antenna. If the feedline intersects the antenna at a current loop (maximum) and a voltage node (minimum) then the antenna is current-fed. The old standby, the half-wave dipole, is current-fed. If the antenna is fed at a voltage loop and current node, then it is voltage-fed. Note that these terms do not correspond to the terms end feed or center feed.

Having decided what type of stub to use, the next step is to measure the standing wave ratio. Hook the feedline directly to the antenna and tune up. CAUTION: do not load to maximum. When these manufacturers say that their super-duper trans-

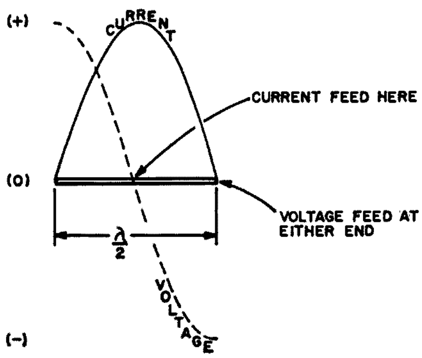

Fig. 3. Current and voltage distribution.

ceiver will deliver 400 watts to a load with an SWR of 2 to 1 or less, they mean it. These finals will not dissipate the reflected power. The feedline may not take the extremes caused by mismatch either. And while measuring, remember that you are radiating some power despite a monstrous SWR. I worked Europe 559 with 60 watts and SWR of 4 to 1, so your signal does cause QRM. If you know the impedance of the antenna, then forget about measuring SWR unless the antenna is not very high or is very near anything that might affect its impedance value. Divide the antenna impedance by the line impedance, or vice versa if the line has the larger value. Using this or the SWR reading (they should be about the same).

Chart 4. For Open-End Stubs

SWR	Wavelengths A	Wavelengths B
1.5	.109	.062
2	.096	.099
3	.083	.138
4	.074	.156
5	.067	.167
6	.062	.178
7	.058	.184
8	.054	.189
9	.051	.193
10	.049	.196
12.5	.044	.202
15	.040	.207
17.5	.038	.210
20	.035	.213

Chart 5. For Closed-End Stubs

SWR	Wavelengths A	Wavelengths B
1.5	.141	.188
2	.152	.151
3	.167	.113
4	.177	.093
5	.184	.081
6	.188	.072
7	.192	.066
8	.196	.061
9	.199	.057
10	.202	.054
12.5	.206	.047
15	.210	.043
17.5	.213	.039
20	.215	.037

Chart 6

Feedline Type	Velocity Factor
Coax (solid dielectric)	.66
Twinlead 75 ohm	.70
150 ohm	.77
300 ohm	.82
Open-wire line	.98

Due to the different dielectrics used, radio waves travel along transmission lines at different speeds, always less than the speed of radio waves in free space. Assuming you now have the wavelength required and the frequency and the velocity

factor, you are now ready to compute the exact lengths needed. Use the following equation:

$$\text{length in feet} = \frac{985}{\text{frequency}} \text{ X velocity}$$

factor X length in wavelengths. You will need to use it twice; once for A, and again for B.

Now that you have the lengths required, merely break into the line at the appropriate point and connect the stub. If you use the arrangement in **Fig. 2**, just connect a stub equal in length to A plus B and hook the feedline onto it at a distance from the antenna equal to A.

Just to make sure you've got the idea, I'll work out an example. Let's assume that I have just put up a two half-waves-in-phase collinear for ten meters. This looks like a dipole except each side is a half-wave-length long. This makes it voltage-fed. Therefore I will use a closed stub. I hook up the 300 ohm twinlead and measure the SWB. I get a reading of about 15 to 1. Next I take a look at chart 5. From this I get a value of .21 wavelengths for A and .04 for B. Using the velocity factor of .82 for twinlead and an operating frequency of 28.1, I get the following equations:

for A

$$\frac{985}{28.1} \times .82 \times .21 = \text{approximately } 6.05 \text{ feet}$$

for B

$$\frac{985}{28.1} \times .82 \times .04 = \text{approximately } 1.15 \text{ feet}$$

Which means that a distance of six feet and one-half inch from the antenna I should insert a stub one foot two inches long, shorted at the end.

It's hard to say just how broadband this type of thing will be. On fifteen meters, by designing around a frequency of 21.050 MHz, I get a standing wave ratio of 1.1 to 1 at 21.0 MHz, and 1.5 to 1 at 21.350 MHz on my bisquare. Being a CW man, I have never been higher than this.

There is no reason why you cannot make the stubs out of coax if you want to. You can use a T-connector or splice it and seal the joint with tape.

This method should eliminate a lot of unnecessary work in tuning the feed system of any antenna that uses stub matching. No

more will you have to make an endless string of hit-or-miss adjustments and oftentimes end up settling for less than the best match. For those who want a more theoretical and detailed explanation, I recommend the ARRL Antenna Handbook. Also, strangely enough, many of the older radio handbooks (pre 1950) give excellent information on this aspect of antennas. I have always found that when it comes to putting up a new antenna, it is always the cost of the feedline that stops me. From now on though, I can feed a new antenna with whatever I can get my hands on. . . . WA5STM

UFO NET

(*Continued from page 2*)

tigation project of the Air Force and mutual cooperation has been assured. Nicap (National Investigations Committee on Aerial Phenomenon) is also interested in our project and has promised cooperation. The cover photograph on the April issue and the photograph at the head of this article were both provided by NICAP. Both photographs are considered authentic and have been exhaustively investigated. The net is also tied in with the 24-hour a day reporting system set up by Franklin Pierce College in Rindge, New Hampshire.

Are UFO's Space Ships?

In spite of the thousands upon thousands of eyeball reports on UFO's by dependable observers, there is still a serious question in many minds about their actual existance. Their existence has yet to be fully proven . . . and so has their lack of existence. The mere possibility that the UFO's do really exist and are space ships is, I am sure, motive enough to warrant the use of every means at our command to investigate the question.

The reports in newspapers of UFO sightings frequently follow very definite patterns across the country. It does appear that if communications were established throughout the country, communities along the projected path of these UFO's might be able to spot them and even get set up to take pictures. If this works out it would not be long before teams could start getting ready for more sophisticated examinations of the UFO's as they pass by.

If we set up our network so that we get immediate reports from every possible source in our communities, we will have made a major contribution to our country. And this sensitive detection system would work two ways. It would report anything spotted to the amateur radio network . . . and the network would report to the "eyes" of the community when anything was heading in that direction, alerting hundreds or even thousands of people to be on the watch.

On the UFO Net

During the establishment of the net it might be of interest to those gathered to review some of the books and magazine articles on UFOs. While some of them are rather obviously far out, others make every attempt to report only carefully checked facts.

It is interesting that many of the governments of the world take the UFO problem quite seriously. I believe that our own government is almost alone today in poo-poohing UFO reports. Those of you who subscribe to Soviet Life or read it in your local library were undoubtedly fascinated by the article in the February issue on UFO reports in Russia and the establishment of a serious program to investigate them. They have mobilized their observatories, weather stations, and all other functions which could help in the quest for answers to the UFO's. Their pilots are taken seriously when they give detailed reports of sightings, unlike the ridicule that American pilots get when they try to give UFO contact reports. Is it likely that the thousands of UFO reports in Russia are just imaginary?

I would like to hear from operators interested in acting as net control for the UFO Net. I will call in whenever I can, but I pretty much work the clock around here at 73 and my air time is sadly scanty. With the backing of 73 I hope that we can get enough operators interested so that we will have a good solid network going. I will be glad to publish reports in 73 of the progress of the net and its accomplishments.

Remember, if the UFO's are not real our network will certainly make this obvious. If they *are real*, then amateur radio may be on the verge of doing the most important piece of PICON in its history. How about you? Are you going to be a part of this? We need every community in the country in this net.

. . . W2NSD

A Ten Meter Folded Dipole Antenna

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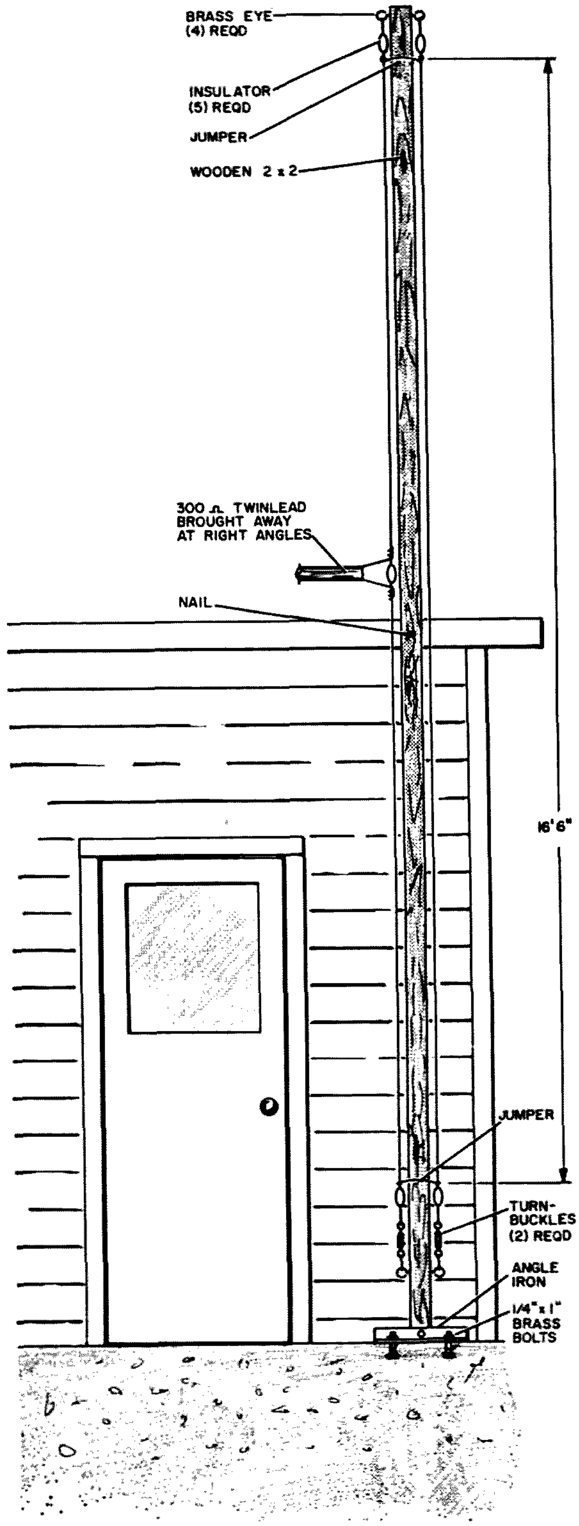
La Jolla, California

Ten meters is open! Along with the opening comes TVI on channel two. The TVI is especially bad on the new broad band TV color sets now coming on the market. To prevent interference the only solution is to use a one band antenna or one that does not radiate the second harmonic. Generally channel two interference cannot be cured with a low pass filter and a high pass on the TV set because the transmitter is sending out on channel two.

The best antenna is a ten meter beam, however, investing in a beam, rotor and tower for the short period that ten is open may be out of the question. The beam after a few years use is left swinging in the breeze during the dry spell. My experience has been to get a beam up just before the band goes dead. Not wanting to go through the cycle again a search was made for a substitute antenna. The selection narrowed down to a vertical folded dipole.



Theory

The length of a folded dipole can be found using the formula $468/f_q$ will give the length of the dipole in feet. The length of 16 ft 6 in is a good compromise for the whole of ten meters. The advantage of using a folded dipole are several: It is a broad band device. This is good for ten meters where the operating range is from 28.0 MHz to 29 MHz. The next advantage and most desirable characteristic is that it does not accept power at twice the fundamental frequency. This means that it should attenuate the channel two harmonic providing there is no capacitive coupling at the tuning end. Cutting the feeders 22-32 feet long or the length 52-64 feet long will also help.

The folded dipole does not accept power at even multiples of the fundamental because the folded section acts as a continuation of a transmission line. The folded dipole is better than a single dipole because the current in the two conductors flows in the same direction and acts as two conductors in parallel and the current therefor in each conductor is divided. Thus the feed line sees a higher impedance because it is delivering the same power at half the current and the impedance is about four times greater at the feed point than a reg-

ular dipole. This enables us to use 300 ohm twin lead to feed the antenna.

The folded dipole antenna mounted in a vertical position with the bottom 12 to 24 inches off the ground offers a low angle of radiation and probably a lower angle than most beams, although, without the gain. The lower angle is really an advantage when reaching out for the extreme DX. The all around pattern is also an advantage for SSB round table discussions.

For the investment the vertical folded dipole is a good solution for those who do not want to put up a beam for the short period of years ten is open.

Construction

Make a trip to the lumber yard and buy a 20 foot 2 x 2 and give it a undercoat and three coats of Z-Spar boat paint. Put two brass screw eyes at the top of the pole and two at the bottom a sufficient distance away to accommodate the length of wire and insulators plus turnbuckles. String the wire on each side of the 2 x 2 between the insulators and tighten the turn buckles. Solder jumpers on each end. The center insulators where the feedline is attached should be a short one. Wires can be soldered from it to several 6-32 machine screws on a piece of lucite which has been screwed to the 2 x 2 to help take the strain when the 300 ohm line is pulling. The 300 ohm twin lead should come away from the antenna about ten feet. It can be held by end slotting some sticks which are then nailed to the house or garage to support the line.

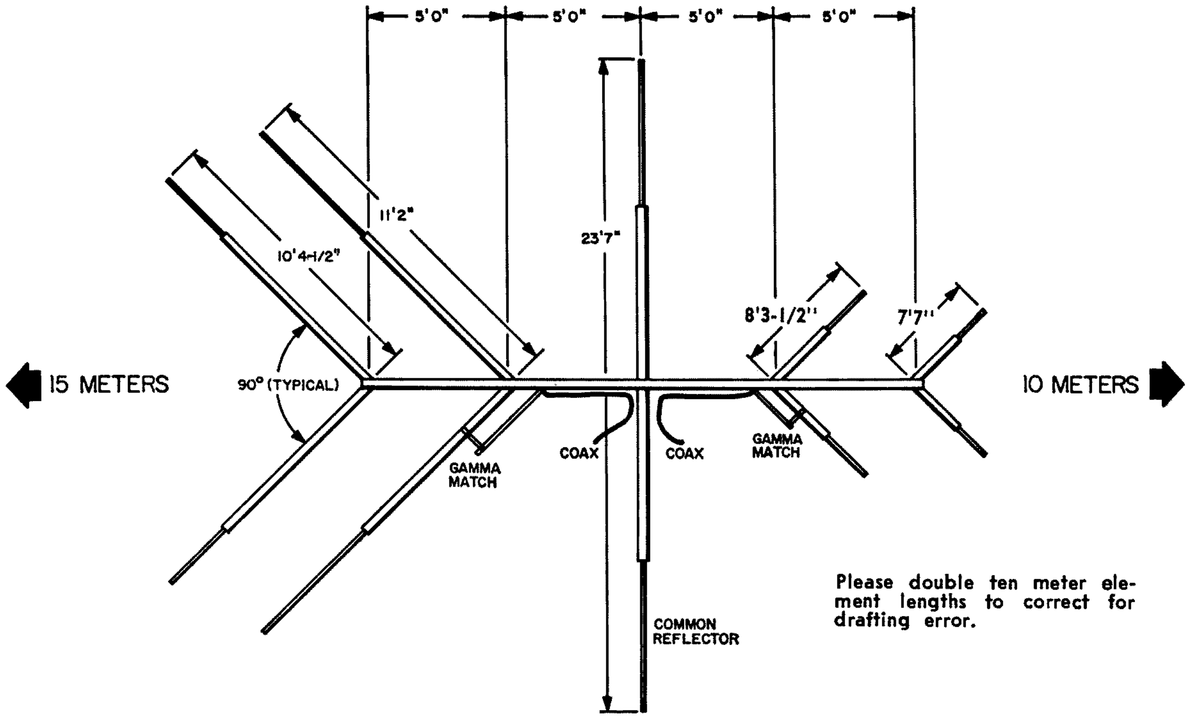
The antenna mast can now be nailed to the eaves of the house or garage. The bottom of the 2 x 2 can be bolted to an angle iron or aluminum four inches long which in turn can be bolted to the concrete with 1/4 x 20 bolts set in the cement. An easy way to do this is to star drill 3/8 holes about 1 inch deep and put the head of the bolt in the hole. Heat some sulphur in a can with a torch and pour it in the hole and it will be secure.

Since most transmitters are PI-Network output it will be necessary to use an antenna tuner. Link coupling to the tuner and with the condenser adjustments will provide a means of obtaining zero SWR throughout the whole of the ten meter band as far as the transmitter is concerned.

Does it work? By the order of the turtle it does. Just as many G's, DL's, DJ's, JA's, LU, VK, and ZL's have been worked with as much ease as with the old four element beam. For the few dollars investment for wood, paint and wire compared with the beam, tower and rotor you can say that I am sold on it!

. . . W6BLZ

The Duo Vee Beam Antenna



M. Eugene Spiess K1UFQ
6 Eastland Drive
Manchester, Conn.

The antenna can truly be called the front end of your rig. Regardless of the quality of the receiver or the transmitter the results that will be achieved will be dependent on the antenna.

To achieve the maximum transfer of energy to or from the antenna there are some items which are necessary to any antenna installation.

1. The elements should be full resonant lengths, no traps or loading coils.
2. The driven element should be resonant at the design frequency.
3. The reflector should not be resonant above the lowest design frequency.
4. Directors should not be resonant below the highest design frequency.
5. The antenna should be mounted as high as possible and in the clear.
6. Some type of matching device must be used at the antenna to match the antenna to the feed line to obtain an SWR of 1:1,

If the above requirements are met a good performing antenna will result. Notice that the matching device must be at the antenna. So many times I have had QSO's and the statement was made, "I have an SWR of 1:1 because I always use an antenna tuner." To be sure this station has a 1:1 SWR but it is between the tuner and the transmitter and what the SWR is between the tuner and the antenna is anyone's guess. There is only one place where a match can be correctly made, and that is at the antenna. Just so no one will get the wrong impression, I have nothing against antenna tuners or couplers. I always use one, not for SWR adjustments but for harmonic suppression and I firmly believe all transmitters should have one in the line with an SWR bridge permanently built in. While we are on the subject of antenna couplers let's discuss the correct place where they should be connected in the line. Here I go sticking my neck out by not going along with technical and hand books, but let's analyze the situation. Let us say we have a perfectly matched beam antenna to a 52 ohm line. We have an antenna coupler between the line and the TR relay. We turn on the transmitter and adjust the coupler for a 1:1 SWR. Let us say the transmitter has a 52 ohm output impedence. Right now we could not have a better situation. The 52 ohm output of the transmitter looks into

the coupler, sees 52 ohms, the coupler looks into the transmission line and sees 52 ohms, the transmission line is terminated at the antenna matching device and sees 52 ohms. All the little electrons are as happy as larks. We now get an answer to our CQ and throw the TR switch to receive. The antenna now is the source of rf instead of our transmitter. The antenna looks into the transmission line and sees 52 ohms, the transmission line looks into the coupler and sees 52 ohms, the coupler looks into the receiver and doesn't know what it is liable to see. Perhaps on some band and some frequency on that band it might see 52 ohms. There is only one place the coupler should be and that is between the transmitter and the TR relay. If you don't believe this, build yourself a receiver antenna coupler and take some S readings.

The reader may well ask at this point what the above has to do with building a Duo Vee Beam Antenna. The answer is nothing regarding the building of the beam, but if the design is not made according to the basic rules as stated this antenna or any other antenna will not give optimum results.

Let's get on with the Duo Vee Beam construction and the reason for its creation. The author has tried all types of antennas except a rhombic, and the reason for not trying a rhombic is because of the terrain at this location. The most outstanding antenna on one band was the four element circular beam that was the brain child of K8CFU.*

The author could find no antenna that could equal this circular quad on one band. But two band operation was desired and as soon as the other elements were added, the original one lost its punch. The handbooks may again say there is no interaction but when "S" units go down, something is causing it. The desire for a two band beam with no interaction was the reason for experimenting and the result was the Duo Vee Beam. The accompaning sketch is self explanatory for building the beam. All the tubing can be obtained in a hardware store along with the aluminum flat stock. The two inch twenty foot aluminum boom is a piece of irrigation tubing. The clamps are TV type clamps.

No value of gain can be given as none was made for the simple reason that without laboratory equipment the readings would have no meaning. Even with laboratory equipment gain readings must be taken with a grain of salt. Suffice it to say that with the Duo Vee Beam fifteen over nine reports from Europe on fifteen meters was obtained and twenty over nine in South America on ten meters, all with an Apache running ninety watts input.

*Archibald Doty, Jr., Box 573, Franklin, Michigan.

With a ground wave signal a F/B ratio shows 24 dB. Note that this F/B was ground wave as a skip signal will cause the F/B ratio to vary depending on the angle of the arriving wave. The sketch shows the dimension for a design for 10 and 15 meters. This antenna can be designed for other bands by the use of the formula ¼ wave length equals $\frac{246}{\text{FMHz}}$ and the tuned by adjusting the telescoping tubing in the elements.

Of course your rotor indicator will read the opposite direction on fifteen if the ten meter side is set to compass directions but this poses no problem, so study the sketch, build yourself a Duo Vee Beam and I'll be looking for you with the strongest signal on the band, Hi. . . . K1UFQ

Computer Design of Beam Antennas

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The purpose of this article is to acquaint the reader with the technique of using a machine to help make a decision, or even to make the decision for him. Computers are used in the business world to make marketing decisions, and in the Pentagon, cost analysis is employed to justify major decisions on the defense of the country.

Many articles have presented to the readers the problems arising in the computer age, with forecasts of dire results to the average man. This article hopes to persuade readers who have doubts about the value of computers, how such machines can be used for helping us reach decisions, even on the merits of antenna systems, a favorite for discussion at the amateur radio club.

The capability of the computer to do arithmetic at fantastic speeds is used in various "languages" where the user commands the machine to do his bidding. One common language is called "Fortran", and a set of instructions makes a program. We can instruct the computer with a Fortran program to do fast calculations on the merits of various systems, provided we realize that initially it knows nothing about the subject and we must prime it with knowledge. If the final result is wrong, it is not the fault of the machine, but of the programmer.

A relatively new development in the use of computers is in the principle of sharing an expensive machine among many customers. The new techniques in computer design have allowed the calculations to be made in less time than a teleprinter will type out the answer. So it is possible for a large computer at a central location to be asked questions by a person many miles away, using ordinary telephone lines to carry the conversation between the computer and an inexpensive teletype terminal. This can be located in an office or even in a home a considerable distance away. This leads us to your home in the not-so-distant future, where your wife will use a distant computer to help her do her shopping! Your children will have been taught how to carry on a conversation with a machine. In fact, programmers today are working towards the ultimate language, which will approximate normal conversation. The future computer will be instructed and will answer in speech, but today we type our instructions.

Most of us who like to dream of antennas on high towers have limited funds, so there is a height of the tower, in conjunction with the number of elements in the beam, which will give best results for our money. The question we want answered is, for a variable height and variable beam size (number of elements), what is the best value in terms of gain per dollar, and is there an optimum height and number of elements we could use for each band. For this article, we shall consider 7 MHz, 14 MHz, 21 MHz, and 28 MHz amateur bands, heights from 20 feet to 100 feet, and beams of the close-spaced Yagi type from one (a rotary dipole) to six elements. Individuals have different ideas on construction techniques, but for amateur home-built antennas we have an idea of the approximate cost of an antenna with a tower. Based on our knowledge, we then derive a formula which seems to be reasonable. Undoubtedly, the formula used will not agree with the experience of many amateurs. However, the principles used can be exploited to suit individual ideas, so your own formulae for gains and costs can be substituted. The cost formula is a little complex, as the tower cost increases with height and also with beam size, requiring greater strength for a heavier load.

First consider power gain relative to a 20 M dipole at 33 feet, or a half wavelength high. As the number of elements increases, the gain increases. As the height increases, the gain increases. As the frequency increases at that height, the gain increases. To simplify the formula for gain we shall assume a linear relationship. So we have Gain = Height x Elements x Frequency divided by a factor A. A 20 M dipole at 33 feet is our reference. Therefore, $1 = 33 \times 1 \times 14 \div A$, $A = 470$. To check A, assume 11 dB gain for a 5 element beam at 66 feet high on 14 MHz.

11 dB is a power gain of 12. Therefore, $12 = 66 \times 5 \times 14 \div A$, $A = 390$. Select a value of 400 as reasonable. Now we have $G = (F \times H \times N)/400$ as one formula for our program. The equation for the cost of the tower plus the beam comes from personal experience and can be varied to suit the individual. In this example, the final result was derived, Cost = 60 x Height x Square root of elements plus 600 x Elements all divided by frequency.

We shall break down the system cost into beam, tower and rotator. A reasonable formula for the beam cost is $\frac{500\ N}{F}$. For example, a 3 element beam at 14 Mc comes to $108, and at 28 Mc would be $54. Some ingenuity will give a 7 Mc 3 element beam for $216. The tower must be stronger as the beam size increases at a given height, so a factor involving N is used in the tower formula, with an estimated cost of $\frac{50 \times H \times \sqrt{N}}{F}$. For example, a 50 foot tower to hold a 14 Mc 3 element beam would cost $310. Adding 20% to the total estimated cost for a rotator gives the final formula.

$$\text{Cost} = \frac{(500\ N + 50\ H \times \sqrt{N}) \times 1.2}{F}$$

Therefore, for the computor,

$$C = \frac{60 \times H \times \sqrt{N} + 600N}{F}$$

Value can be defined as performance versus cost, or in this case, decibels of gain for our dollars. Transfer the gain into decibels by a logarithmic function to suit our formula, and we get, $V = \text{Log } G./C$.

We are interested in the *maximum* value obtained from 7 MHz to 28 MHz for all combinations of heights from 20 feet to 100 feet in steps of 2 feet, with antennas from one to six elements.

Each new calculation of V is compared with the previous, and the larger of the two selected. First, at F=7 MHz for a range of heights from 20 feet to 100 feet, the best value in dB per dollar is found for a dipole (one element). Then the computer goes through the next loop calculating the best value for a two element beam at all heights, comparing with the previous best for a dipole, and storing the maximum in its memory. The process is repeated up to six elements. The best value for the first frequency of interest, 7 MHz, is then printed. Similarly, the maximum dB per dollar is printed for 14 MHz, 21 MHz and 28 MHz. We shall see lines of print informing us of frequency, number of elements, height, gain in dB, and cost for the best value at that frequency.

Note that the figures shown apply to single beams on towers, so it should be obvious that we shall get better value for our money by using a tri-band beam on one tower.

Don Gordon, W4VTT, pointed out that an extension of the program would be to simulate the conditions when we have limited funds available, a common occurrence! He rewrote the program to find out the best beam size versus height for fixed costs, selecting $300, $400, $500 and $600. The comparison in value now is limited at a fixed cost in each case, and the print has an additional column, allowable cost. The print-out is now frequency, number of elements, height, gain, true cost, and maximum allowable cost. The performance in gain is compared to a half-wave rotary dipole at a half wavelength high, so the dipole on 7 MHz at 24 feet has a loss of 3 dB with reference to a height of 66 feet. If you have $600 available for a 28 MHz beam, using amateur construction techniques, the computer shows a 6 element beam almost 3 wavelengths high with a gain of 15 dB over a dipole at 16 feet.

We have seen how the computer can give answers rapidly when primed with knowledge. Knowledge is gained by learning, and in the average human being is a long, slow and sometimes painful process. But the computer can be rapidly educated, or re-educated. Suppose in our case we do not agree with our educated machine. We can erase the knowledge we primed it with, in other words, alter the formulas we had.

Among DX antenna enthusiasts there is always the old argument of height against beam size. Some believe in height, others believe in large beams. Our program so far can be seen to favor large beams at medium heights for best value for the dollar. For those who disagree, we can re-educate the computer by emphasizing the value of height. Instead of a 3 dB increase on doubling the height, we can assume a 6 dB

increase. We now incorporate a new formula for gain. A 6 dB increase is 4 times the power, so power increases as the square of height. The gain formula is now re-written, $G = (F \times H)^2 \times N/A$. Again we know $G = 1$ for a dipole at a half wavelength high. Recalculating for A gives the value of 220,000. We prime the computer with this new formula and run the program again. The results are shown to suit the height-oriented DX chaser.

Note that a new formula for gain does not allow us to compare the actual dB shown in the gain column from one program to another. Gain comparisons should be made only within the formula used. For example, in the list of 28 MHz antennas at $300, $400, $500 and $600, we see that the increase in gain is 6 dB from $300 outlay to $600, while at 7 MHz the increase is from −8 dB to 0 or plus 8 dB for a 7 MHz rotary dipole increasing in height from 24 feet to 60 feet.

We can now draw some conclusions from the four programs. The first gain formula, which emphasizes the large beams, shows that at 7 MHz we must be prepared to invest a large sum to get the best value from the antenna system, $1386 for a large 5 element beam at 50 feet high. The second formula for gain, which is oriented to suit the height-conscious amateur asks for even more money for a 3 element beam on 7 MHz at 100 feet high, quite an antenna!

The favorite DX band is 20 Meters, so our two best values there are of interest. The first formula gives a 3 element beam at 40 feet for a cost of $425. The second formula, which emphasizes height, shows almost the same cost for a rotary dipole 100 feet high. It is a debatable point which of the two would give the strongest signal at a remote location.

Now let us examine the systems available for the fixed costs of $300 to $600. Our new gain formula should not make any difference in the inexpensive 7 MHz antenna, but the higher frequencies will be height oriented again. The 14 MHz antenna for $600 in the first instance is a 4 element beam at 50 feet, and in the second case is a 2 element beam at 84 feet. For $300, the choice is between 2 elements at 34 feet and a rotary dipole at 60 feet. At the highest frequency we have considered, 28 MHz, at the maximum allowable cost of $600, we can choose between a six element beam at 88 feet, or five elements at 100 feet.

Consider the time required to calculate all the values by conventional means, then compare our first print-out of maximum values taking 11½ seconds and the second print-out taking less than half a minute of computer time!

The whole conversation with the computer for the two programs is shown, but no attempt is made to explain details. For those interested, books on Fortran are easily obtainable. You can substitute your own formulae to determine values for quad antennas, and the computer can then answer the old question, yagi versus quad! The result will vary, of course, depending on the individual amateur's formulae, and the total result of this article will probably be to have more heated discussions in the club room.

```
System—Fortran
New or Old—New
New Problem Name—Antval
Ready.

Tape
Ready.

100 Print "Fortran for antenna cost vs. performance"
110 Print 10
120 10 Format (1H14X4HFREQ4X4HELEM4X4
    HHGHT4X4HGAIN4X4HCOST)
130 DO 4 F = 7, 28, 7
140 Z = O
150 DO 1 N = 1, 6, 1
160 DO 2 H = 20, 100, 2
170 G = F*H*N/400
180 C = (60*H*SQRT(N) + 600*N)/F
190 V = (LOGF(G))/C
200 IF (Z — V)3, 3, 2
210 3 Z = V
220 P = N
230 Q = H
240 R = 4.3*(LOGF(G))
250 S = C
260 2 Continue
270 1 Continue
280 Print! 5, F, P, Q, R, S
290 5 Format (518)
300 4 Continue
310 End

Key
Ready.

Run
Wait

ANTVAL     13:32     W1 MON 12/11/67
```

Fortran for Antenna Cost vs. Performance

I	Freq	Elem	Hght	Gain	Cost
	7	5	50	6	1386
	14	3	40	6	425
	21	3	30	6	234
	28	2	30	6	133

At line No. 310: Stop End, Ran 69/6 Sec.

System—Fortran
New or Old—Old
Old Problem Name—ANTCST
Wait.

Ready.

List

```
ANTCST       13:22     WI MON 12/11/67
100 Print "Best Antenna Gain for Fixed Cost"
110 Print 10
120 10 Format (1H14X4HFREQ4X4HELEM
       4X4HHGHT4X4HGAIN4X4HCOST4X4HMAX$)
130 DO 8 F = 7, 28, 7
140 R = Q
150 DO 7 M = 300, 600, 100
160 DO 3 N = 1, 6, i
170 DO 1 H = 20, 100, 2
180 G = F*H*N/400
190 IF (G-R)1, 1, 2
200 2 C = (60*H*SQRT(N) + 600*N)/F
210 IF (M-C)1, 4, 4
220 4 R = G; P = N; Q = H; S = C
230 1 Continue
240 3 Continue
260 D = 4.3*LOG(R)
270 Print 6, F, P, Q, D, S, M
280 6 Format (6I8)
290 7 Continue
300 8 Continue
310 End
```

Run

ANTCST 13:25 WI MON 12/11/67
Best Antenna Gain for Fixed Cost.

I	Freq	Elem	Hght	Gain	Cost	Max$
	7	1	24	−3	291	300
	7	1	36	−1	394	400
	7	2	26	0	486	500
	7	2	34	0	583	600
	14	2	34	3	291	300
	14	3	36	5	395	400
	14	4	38	7	497	500
	14	4	50	8	600	600
	21	4	32	8	297	300
	21	4	50	10	400	400
	21	6	46	11	493	500
	21	6	60	12	591	600
	28	4	50	11	300	300
	28	5	60	13	394	400
	28	6	70	14	495	500
	28	6	88	15	590	600

At Line No. 310: Stop End, Ran 169/6 Sec.

170 G = (F*H) ↑ 2*N/220000
Run

Anyval 13:47 W1 Wed 12/27/67

Fortran for Antenna Cost vs. Performance

I	Freq	Elem	Hght	Gain	Cost
	7	3	100	8	1741
	14	1	100	9	471
	21	1	70	9	228
	28	1	54	10	137

At line No. 310: Stop End, Ran 72/6 Sec.

180 G = (F*H) ↑ 2*N/220000
Run

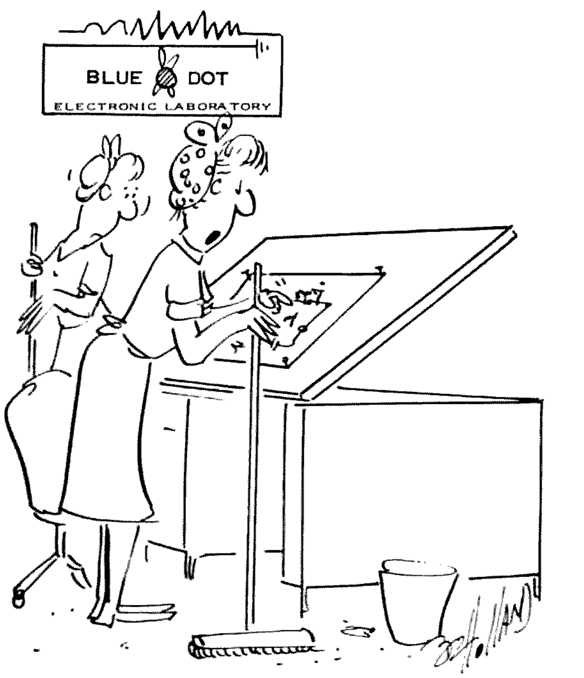
ANTCST 13:41 W1 WED 12/27/67

Best Antenna Gain for Fixed Cost

I	Freq	Elem	Hght	Gain	Cost	Max$
	7	1	24	—8	291	300
	7	1	36	—5	394	400
	7	1	48	—2	497	500
	7	1	60	0	600	600
	14	1	60	5	300	300
	14	1	82	7	394	400
	14	1	100	9	471	500
	14	2	84	10	594	600
	21	1	94	12	297	300
	21	2	84	14	396	400
	21	3	82	15	491	500
	21	3	100	17	580	600
	28	2	84	16	297	300
	28	3	90	19	398	400
	28	4	96	20	497	500
	28	5	100	22	586	600

At Line No. 310: Stop End, Ran 182/6 Sec.

. . . WA4WWM



"SHUCKS...THAT LITTLE OL' 500 OHM RESISTOR AIN'T ENOUGH TO BY-PASS ANY EXCESS CURRENT."

A Primer of Basic Antenna Theory

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Antennas are a very popular subject among radio amateurs today, as they have been almost from the beginning of radio science. In fact, of all the pieces of equipment an amateur owns the one he probably spends the most time talking about, both on and off the air, is his antenna. There are at least two good reasons for this. First, the antennas themselves are pretty simple, at least from the standpoint of circuitry. They contain no transistors or vacuum tubes or other amplifying, oscillating, modulating or detecting devices, the exact operations of which are difficult to comprehend. Antennas are usually simply pieces of wire or tubing with perhaps a transformer thrown in for impedance matching. Thus, they are at least easy to visualize.

The second reason for the great deal of attention antennas get is their performance. Every ham who has been around very long knows that there is no easier way to improve his station's capabilities than to improve his antenna. When a significant change for the better is made in the antenna, the improvement in the station's ability to communicate is immediately apparent, on both transmission and reception. Seven hundred dollars (the usual price of a storebought kilowatt amplifier these days) spent on an antenna installation will do worlds more good for the amateur than will a similar amount spent on a big "pair of shoes" for the exciter.

Also, antennas are popular because they are easier to homebrew than most pieces of equipment, and easier to make operate properly after their construction.

Thus, the antenna deserves its popularity. And if this is so, then the simple theory behind the antenna deserves to be understood by us all. So, the reason for this article. These few pages will discuss the very simple theory of antenna gain, efficiency, capture area and effective height. These are subjects of which very few amateurs seem to have a good grasp today. Much is heard about antenna "gain" especially, but few seem to have an exact understanding of what they are speaking about. Perhaps this article will help to clear up a little of the confusion.

Antenna reciprocity

An antenna can basically be thought of as a device for converting energy from one form to another. When an electromagnetic (EM) wave strikes an antenna we find that electrical power is available at its terminals. On the other hand, when we apply electrical power to the terminals of the antenna, we find that an EM wave is radiated by the antenna. Thus, the antenna is capable of converting electrical energy to EM energy, and EM energy to electrical energy. This property of working both "backward and forward" is called "reciprocity" and is characteristic of antennas.

Now because the antenna is only a go-between for conversion of electrical to EM energy and vice-versa, a complete understanding of even basic antenna theory cannot be had without also obtaining some basic knowledge about EM fields, and electrical circuits as applied to antennas. Consequently, in this article we shall first discuss some things about EM fields before turning to antennas themselves. Later we will discuss basic antenna circuitry.

Electromagnetic fields

Most of us realize that it is EM fields or "waves" that provide the invisible link between transmitting and receiving stations in a radio communications system. But the fact is that no one, even the professionals, knows just what an EM field is.

For several thousand years men have

known that, after being rubbed, certain substances, amber for instance, would attract other bodies. This was a form of action at a distance, and came to be called "electric" attraction. Other substances, such as lodestone, could also attract matter at a distance, but did not require rubbing. This sort of attraction became known as "magnetic" to differentiate it from electric attraction from which it appeared to be different. These sorts of attraction remained a puzzle for thousands of years and to some degree are still puzzling. But thanks to the work of James Clerk Maxwell, engineers and physicists today have a mathematical grip, at least, on the elusive phenomenon of electromagnetism. Maxwell's theoretical work showed that there was a very definite relationship between electric and magnetic fields, and that they were really parts of the same natural phenomenon. Eventually he was able to express the relationship between the electric and magnetic fields as a set of two mathematical expressions which have come to be known as "Maxwell's Equations." These equations have been the foundation upon which most all mathematical EM theory has been built since.

The Traveling wave

As far as radio systems are concerned the most significant feature of EM fields is their ability to move, that is, to transport energy from one place to another. These fields are called "traveling waves" and are composed of two components, an electric field component and a magnetic field component. If a person were able to stand in one place and watch an EM wave pass by he would see the energy in the wave alternately in the electric and magnetic form. Actually, the transformation of the energy from one form to the other is gradual (sinusoidal) and is complete only at an instant each cycle.

The speed with which the transformation of the energy takes place is known as the frequency of the wave. For example, if the transformation from electric to magnetic and back to electric (one complete cycle) takes place once every millionth of a second, the frequency of the wave is 1,000,000 cycles per second, or one megahertz.

Electromagnetic energy in the form of a traveling wave moves at a tremendous rate of speed, about 300,000,000 meters per second. The wavelength of a particular moving EM field is the distance the wave moves during one cycle. For our one megahertz wave above it is 300,000,000 divided by 1,000,000 or 300 meters. This relationship between frequency and wavelength can be expressed algebraically:

$$(1) \quad C = f\lambda,$$

where: C = speed of light
= 300 million meters/second
f = frequency, Hertz
λ = wavelength, meters.

Power density

If you drop a stone in a quiet pond, small waves will radiate away from the point where the stone struck the water. Each wave will have a circular form around the starting point, and will move away from the source. Thus we can say that the waves have a circular wavefront.

Now if we visualize a "point source" of EM energy situated in space it is easy to imagine that EM waves will radiate away from the source, and form a spherical wavefront. The surface area of this spherical wavefront will of course depend on its distance from the point source. From high-school geometry we remember that:

$$S = 4\pi r^2,$$

where: S = surface area of sphere, meters (m^2)
π = 3.14
r = radius of sphere, meters.

Then if the point source were to radiate a certain amount of energy every second (i.e., power), the EM power would be distributed over an ever increasing surface area as a particular wave radiated away from the source. Notice that the total power is not diminished, it is just spread over a greater and greater area as we move further and further from the source.

The amount of electromagnetic power contained in a unit of surface area on the wave front is termed the "power density" of the EM wave, and depends on the distance from the source:

$$(2) \quad D = \frac{P}{4\pi r^2},$$

where: D = power density, watts/m^2
P = radiated power, watts.

Thus we see that as the wavefront moves away from the source, the power density decreases with the square of the distance from the source. This decrease of power density is termed "spherical divergence". It means that the EM wave is diverging or spreading out as it moves away from its origin.

As we can see from the above, a very convenient way of measuring the amplitude of an EM field is to measure its power density. Power density is today one of the most commonly used measures of EM field magnitude.

Field strength

We mentioned above that the EM field is made up of two components—the electric field and the magnetic field. Since the EM field is capable of transmitting power from one place to another it seems reasonable that the power must be embodied in the two field components, and indeed this is the case. Thus if we were to increase the power level (and consequently the power density), there would necessarily be a corresponding increase in the strength of the electric and magnetic field components.

The mathematics which governs the relation between the power density, electric field strength and magnetic field strength is quite simple:

$$(3) \quad D = EH,$$

where: E = electric field strength, volts/meter
H = magnetic field strength, amperes/meter.

This equation holds so long as the point of measurement is at least a few wavelengths from the transmitting source, which is a reasonable assumption in radio systems.

There is also a very simple relation between the electric and magnetic field strengths:

$$(4) \quad E = Z_o H,$$

where: Z_o = intrinsic impedance of space
= 377 ohms.

You have probably noticed the similarity between Ohm's Law and Equation (4) above. Now if we combine Equations (3) and (4), we obtain two other simple expressions for EM power density:

$$(5) \quad D = \frac{E^2}{377}, \text{ and}$$

$$(6) \quad D = 377H^2.$$

Summary

We have now discussed the very basic elements of EM theory necessary to an understanding of antennas. The concepts of point sources, electric and magnetic fields, frequency, wavelength, power density and field strength have been explained. Power density and electric and magnetic field strength are particularly important to understand, because they are what we measure in order to determine the amplitude of an EM field. Making a measurement of either D, E or H is equivalent to specifying all three, because they are all simply related by Equations (3) to (6). We are now ready to push on to antennas themselves.

We mentioned before that an antenna was a reciprocal device—that it worked both forward and backward. This means that the theory for both transmitting and receiving antennas must be identical. Thus it is only necessary to discuss one type, either transmitting or receiving, and the conclusions will be found to hold for both. For the purposes of this article we will discuss the antenna from the transmitting point of view, because it is easiest to visualze. Later we will have some comments about the receiving antenna.

Antenna equivalent circuit

When an antenna is attached to the output terminals of a transmitter, power flows from the transmitter output to the antenna and is radiated electromagnetically. The antenna loads the transmitter, the same as an impedance would. Thus the antenna could be represented, as far as the transmitter is concerned, by an impedance. Almost always the antenna is tuned to resonance (or nearly so) at the operating frequency, so that the impedance it presents to the transmitter is purely resistive. Then the input impedance of the antenna is purely resistive, and the antenna could be represented by the simple equivalent circuit of **Fig. 1**.

In **Fig. 1**, R is a resistance equal in value to the antenna input impedance. The transmitter knows not whether an antenna of input impedance R, or a simple resistor of

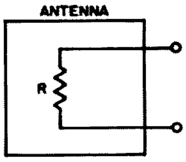

Fig. 1. Simplest antenna equivalent circuit.

R ohms is connected to its output terminals.

Radiation efficiency

Actually in a practical antenna not all of its input power is radiated as EM signal energy. Some is also radiated as heat, due to losses in the antenna structure. (Heat is just another form of EM energy. It is "incoherent" and at an extremely high frequency.) Losses in an antenna structure stem from several sources: dielectric losses in supporting insulators, resistive losses in the antenna system conductors, losses due to leakage currents over insulators, losses due to currents induced in nearby conductors and the ground, and corona loss. These losses can be minimized by proper design and location of the antenna.

In order to represent the splitting of the antenna input power into two parts, we split R into two parts and represent the antenna as in **Fig. 2.** Here R_r represents the portion of the input power that is radiated as useful signal power, and is called the "radiation resistance". R_l represents that portion of input power which is lost as heat, and is called the "loss resistance".

In order for an antenna to be a good

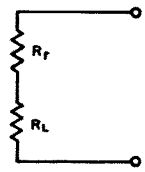

Fig. 2. Antenna equivalent circuit, includng effect of losses. R_r is the radiation resistance, R_l the loss resistance.

radiator, it should have very low R_l in relation to R_r, or in other words, by far the greatest portion of antenna input power should be radiated as useful signal. The "radiation efficiency" of an antenna is expressed mathematically like this:

$$(7) \quad \eta = \frac{R_r + R_l}{R_r},$$

where: η = radiation efficiency
R_r = radiation resistance, ohms
R_l = loss resistance, ohms

If we desire to maximize this radiation efficiency, we want R_l to be small in comparison to R_r. In the extreme case of a perfect radiator, R_l would be zero and then η would be equal to 1, or 100%. When R_l increases from zero the efficiency drops, and if R_l should equal R_r, for example, then η would be only ½, or 50%.

The Isotropic antenna

An isotropic antenna is one which radiates equally well in all directions. It is similar to the point source which we discussed before. Such an antenna is a convenient reference to use for measuring the "gain" of another antenna, although in reality there is no antenna which is truly isotropic.

Antenna gain

When discussing the "gain" of an antenna, it should be emphasized that there are two kinds of gain—power gain and directive gain (sometimes called directivity). The two are related by a simple expression which includes radiation efficiency:

$$(8) \quad G_p = \eta \, G_d,$$

where: G_p = antenna power gain
G_d = antenna directive gain.

Suppose, for example, that an antenna with a radiation efficiency of 50% had a directive gain of 4 (6 db). Using Equation (8) then, power gain would be ½ times 4, or 2 (3 db). But what do these terms power gain and directive gain mean?

Any antenna which is not isotropic has some directive gain. The directive gain is only a measure of the ability of the antenna to radiate in one direction to the exclusion of others. In other words, directive gain is a measure of the *shape* of the "radiation pattern" of an antenna, as compared with the circular shape of the radiation pattern of an isotropic antenna.

Power gain, on the other hand, includes not only the shape of the radiation pattern, but also the size of the pattern, or, in other words, it measures how effectively the antenna radiates in a particular direction.

An example should serve to make the above concepts clear. In **Fig. 3** we have the radiation patterns (in two dimensions) of three antennas—a 100% efficient isotropic antenna (antenna A), and two directive arrays, each with a directive gain of 4. One of the directive arrays, antenna

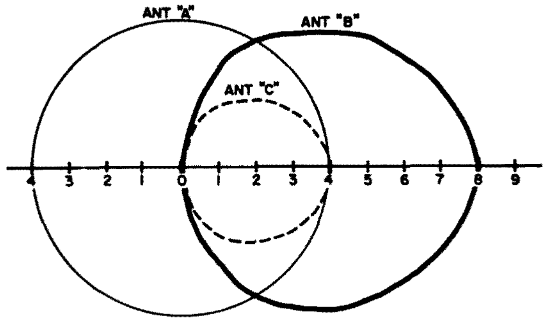

Fig. 3. Radiation patterns of three antennas, one isotropic.

B, has a radiation efficiency of 100%, and the other, antenna C, an η of only 25%. Notice that the *shape* of the patterns of antennas B and C is the same, only the size is different. Also note that in the favored direction, antenna C is no more effective a radiator than the isotropic. Nonetheless it has directive gain, due to its ability to radiate better in the favored direction than in others.

Antenna B, on the other hand, has the same directive gain as antenna C, since the shape of its radiation pattern is the same. But its efficiency is four times greater, and thus, as shown in the diagram, is a much more effective radiator in the favored direction.

The power gain of antenna B is, from Equation (8):

$$G_p \text{ (antenna B)} = \eta G_d = 1 \times 4 = 4 \text{ (6 db)}.$$

For antenna C, the power gain is:

$$G_p \text{ (antenna C)} = \tfrac{1}{4} \times 4 = 1 \text{ (0 db)}.$$

The G_p, G_d and η for the three antennas is summarized in **Fig. 4.**

ANTENNA	A	B	C
POWER GAIN, G_p	1	4	1
DIRECTIVE GAIN, G_d	1	4	4
RADIATION EFFICIENCY, η	1	1	1/4

Fig. 4. A summarization of the power gain, directive gain and radiation efficiency for the antennas of Fig. 3.

Power gain can also be thought of as the power density of the EM wave radiated by a directive antenna in its favored direction, divided by the power density radiated by a 100% efficient isotropic antenna in the same direction. In **Fig. 3** antenna B gives twice as much field strength in the desired direction than does the isotropic antenna. And since power density, from

Equation (5), is proportional to field strength squared, it gives four times as much power density. Thus its power gain is 4. Antenna C, on the other hand, gives identically the same field strength, and therefore power density, as the isotropic, and thus its power gain is 1. From this it can be seen that power gain can be determined from an antenna's radiation pattern.

At this point let's look at a practical example of power gain versus directive gain. A three-element yagi, optimally designed and adjusted, has a maximum directive gain of about 11.7 (10.7 db). However, if loading coils or traps are added to the elements to decrease their size, or provide for automatic bandswitching, the efficiency is decreased due to losses in the wire from which the coils are wound. If the efficiency is decreased to as little as 80% (not an unrealistic figure in the case of tri-band beams), the power gain will suffer by about 1 db. Of course this small price has been paid for added flexibility in the antenna system.

Normally power gain and directive gain are measured with respect to an isotropic antenna, as we have done in the examples above. Historically this has not always been the case, however. In the earlier days of radio, gain was most often measured with respect to a half-wave dipole antenna, and this is still done today in the amateur radio community. The gain (either power or directive) is less when measured with respect to a dipole than with respect to an isotropic, because a dipole itself has gain with respect to an isotropic antenna. A 100% efficient dipole antenna has a power gain of 1.64 (2.15 db) with respect to an isotropic. Thus to convert a gain figure measured with respect to a dipole to that with respect to an isotropic, the figure should be multiplied by 1.64.

Which gain is important?

The question now arises, Which gain, directive or power, is important in a radio system? In the transmitting system, power gain is the most meaningful criterion of antenna effectiveness, since the ultimate aim is to radiate in the direction of the receiving station an EM field with the greatest power density. Power gain gives a good measure here because it includes both directivity and radiation efficiency.

In a receiving system, the important type of antenna gain depends on noise, and its

origin. If the largest portion of the receiver output noise originates in the receiver itself, power gain is necessary in the antenna. This is normally the case in the frequency range above about 30 MHz. But if the output noise originates external to the receiving system, such as is the case with atmospheric noise below 30 MHz, then only directive gain is necessary in the antenna.

Normally below 30 MHz we amateurs use an antenna with high power gain for both receiving and transmitting, since it allows us to get by with only one antenna. When transmitting the power gain is necessary to system effectiveness, but for receiving it is not, although it certainly does no harm. By sacrificing efficiency (which we don't need anyway) we could use a physically much smaller receiving antenna, though, and get equal results. At least one manufacturer is taking advantage of this principle in small receiving antennas being built for the commercial services.

Summary

Some important conclusions can now be stated from our study of antenna gain. First, when speaking of antenna "gain" two things must be stated for clarity—the type of gain referred to, power or directive, and the reference, isotropic or dipole. Second, high radiation efficiency, while always desirable in a transmitting antenna is not necessary for receiving antennas below 30 MHz where the large majority of the receiver output noise originates outside the antenna. With low efficiency both the signal and noise are reduced proportionately in the antenna, and therefore the signal-to-noise ratio is largely unaffected.

Receiving Antennas

So far as transmitting antennas are concerned, we have now covered the basics, but for receiving antennas we have more work to do. While the antenna parameters we have specified and described above for transmitting antennas are also adequate for receiving antennas, two other unique terms have come into great usage to describe receiving antennas, capture area and effective height.

Capture Area

When using an antenna for receiving purposes, it is usually desirable to know the amount of signal power available from the

antenna output, to be supplied to the receiver input. From the power density of the EM field of the signal we know the amount of power per unit area in the field. If we knew the effective capture area of the receiving antenna, then, we could find the power available from the antenna simply by multiplying the power density and capture area together. Thus, the capture area is the ratio of the power available at the antenna terminals to the power density of the intercepted EM field. Capture area is related to the power gain of the antenna, and the wavelength of the field by:

$$(9) \quad A = G_p \times \frac{\lambda^2}{4\pi},$$

where: A = antenna capture area.

Let's take a simple example. Say the wavelength is 7.1 meters and G_p of the antenna is 8 (9 db). The capture area then is $8 \times \frac{7.1 \times 7.1}{4 \times 3.14} = 32$ square meters. Then if the power density of the EM field striking the antenna were 2 nanowatts per square meter, the power available at the antenna terminals would be 2 x 32 = 64 nanowatts.

Large capture area is essential if a VHF antenna is to be highly effective for receiving purposes. But Equation (9) shows that capture area decreases with the square of wavelength. Therefore, as we go to higher frequencies, and consequent shorter wavelengths, power gain must be rapidly increased if we are to maintain a respectable capture area. The result of all this is that highly effective VHF antennas are just as physically large as those for the lower frequencies, despite the shorter wavelengths. They must be in order to develop the proportionately higher power gains necessary to maintain a high capture area.

Capture area is coming to be used more and more today as a measure of VHF and UHF receiving antenna effectiveness. Historically, however, antenna "effective height" came first, and we will explain that next.

Effective height

Back in the days when regular AM broadcasting was getting its start, the amplitude of an EM field was most often specified by its electric field strength, E. Power density was very seldom used. Consequently, an antenna "transfer function" was needed which

was based on field strength rather than power density. The term settled on was "effective height", and it was defined in terms of the voltage measured at the antenna terminals with no load connected across those terminals (the open-circuit voltage):

(10)

$$L = \frac{\text{antenna open-circuit terminal voltage}}{\text{electric field strength, E}}$$

$= $ antenna effective height.

This choice has turned out to be a bit ambiguous for two reasons. First, for a given field amplitude, it gives only the voltage available from the antenna. Ths is ambiguous for a given antenna because it depends on where the antenna is fed. If the feed terminals of a dipole antenna, for example, are located at its center the open-circuit voltage is much lower than when the terminals are located a good deal off center. And besides, it takes power to drive a receiver anyway.

Second, the term "height" has proved to be unfortunate because it implies how high the antenna is above ground, which connotation is purely incidental. A much better word here would have been "length", and indeed it is now coming into wide usage.

An amateur frequencies and higher, antenna capture area is gradually replacing the usage of effective height, especially among professionals. Its usage among amateurs should also be encouraged, but the old term is still hanging on with real tenacity.

Conclusion

This article should have given you a basic insight into antenna theory. The knowledge you have gained will enable you to interpret antenna literature more wisely, and this in turn will mean better antennas at your station for the dollars you have to spend.

. . . K6ZGQ/5

CLUB SECRETARIES NOTE

Club members would do well to get their club secretaries to drop a line to 73 and ask for the special club subscription scheme that we have evolved. This plan not only saves each club member money, it also brings badly needed loot into the club treasury, if desired. Write: Club Finagle, 73 Magazine, Peter Boro Ugh, New Ham Shire 03458.

1968 HAMFEST AT 73

Come on up July 6th and visit New Hampshire

Ever since our last hamfest, in 1965, everyone has been after us to have a repeat performance. The editorial in February explained some of the reasons for the delay.

This year we are going to do it again. July 4th comes on Thursday this year, so we will schedule our Hamfest for Saturday, July 6th. We'll try to have lots of entertainment for you on Saturday. We'll have more details on this later, but it looks as if the VHF gang will have a chance to bring their 144 and 432 MHz antennas for a measuring contest run by Leger Laboratories. I expect that André of Vanguard will be up here with all of his latest products; plus many other 73 advertisers.

We'll organize an auction of gear, so bring stuff you want to sell and lot's of money to grab the bargains. Last time thousands of dollars worth of gear changed hands and I'm afraid the buyers got some incredible bargains.

Saturday evening I will show some of the slides of my DXpedition to those interested in seeing some pictures of weird places.

Early Sunday morning we will form a caravan heading north into the White Mountains, about 100 miles away. There we will visit some of the tourist attractions that have made New Hampshire the most visited tourist state in the East. We will see the famous Old Stone Face, the great New Hampshire Man of the Mountains. We'll see and walk up through the Flume. We'll take the tramway to the top of Canon Mountain for one of the panoramas of a lifetime. We'll see the beautiful Old Man's Foot Basin. We'll stop off at Clark's Trading Post and see and hear some of the old time music boxes and see the trained bears. We'll visit the historic Morse Museum and, if we can work it in, climb through the caverns of Lost River.

New York is just a little over 300 miles of turnpike driving away, so those that have to get back can make it Sunday evening. For the rest we can drive or take the cog railway to the top of Mount Washington on Monday morning. The more athletic can start from the cog railway station at the base and climb the mountain.

This will be an outing that the whole family will enjoy. There are many beautiful picnic spots near Peterborough and we show them on a special map that we have printed of the Monadnock region of New Hampshire. You can get one of these maps when you arrive or send us a SASE and we will send you one right away. This map also shows points of interest in this area, restaurants, etc.

Mobileers will want to try their luck from the top of Pack Monadnock, just 3.5 miles east of the 73 headquarters. You can drive right to the top of this mountain and get a straight shot right into Boston and down to New York.

At any rate, if you can get away for a couple of days or so, why not join us up here at 73 for a couple of days of fun and sightseeing around New Hampshire?

. . . W2NSD/1

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Torrance, California

Triangular Loop Beam 7 thru 28 MHz

Introduction

The writer, returning to amateur communications after thirty years away from it, found antennas a source of interest. Accordingly, during two years while part of spare time available was being spent in obtaining an extra class license and building a tilting tower, a research program was carried out oriented to a few long-wire antennas, such as the rhombic, and to beam antennas. Calculations and literature research covering log-periodic dipoles and monopoles, helices and phased arrays together with experimentation led to design of the antenna described herein. This antenna incorporates on a 28 foot outrigger boom, four triangular loop elements comprising a two-element beam on 7 MHz and four-element beams on 14, 21 and 28 MHz. Apertures and gain of a number of element configurations are compared and experiments with square and triangular loops are covered.

Antenna design criteria

The following criteria for an amateur antenna were traded off in evolution of the triangular-loop-beam:

- Operation on 7 thru 28 MHz bands
- Rotary beam to maximize effectiveness
- 3 to 5 dB gain on 7 MHz and 8-9 dB gain on 14, 21 and 28 MHz as compared to a dipole
- KW power capability
- High radiation efficiency
- Withstand 85 mph winds coupled with ice loads
- Turning radius of 17 feet maximum
- Minimum weight and cost commensurate with design capable of amateur construction.

Loop Beam vs Helix

The multiple loop beam antenna is merely a special case of the axial mode helix an-

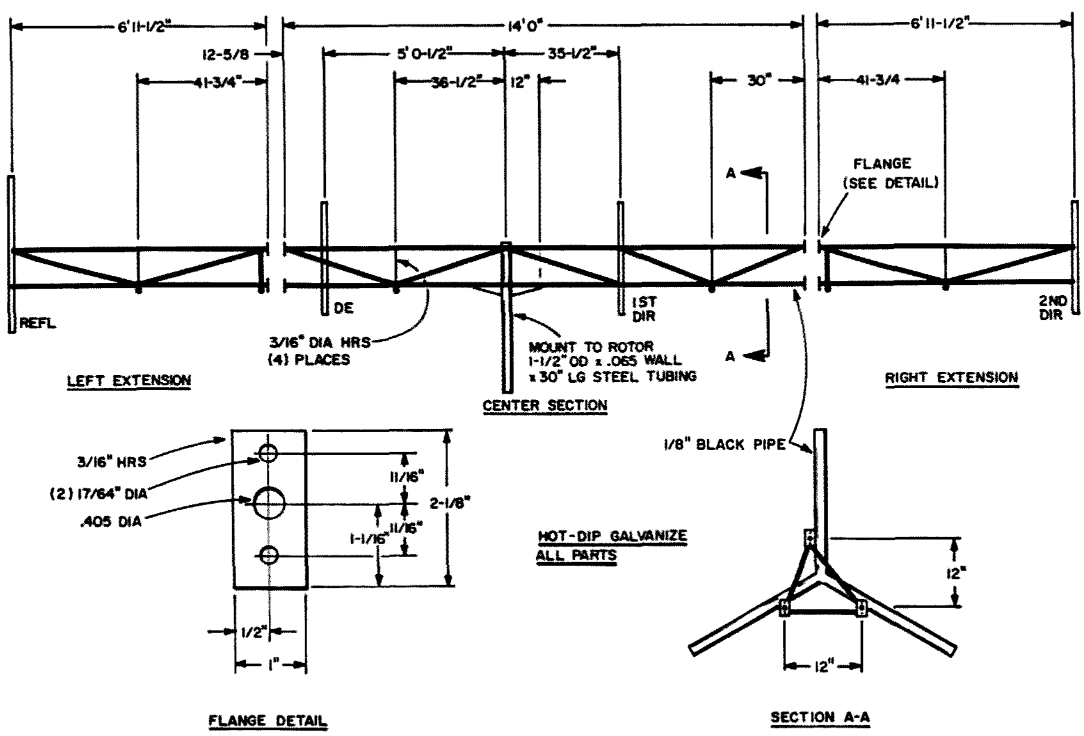


Fig. 1. Truss boom construction details

tenna in which the helix pitch is zero. The other extreme of the helix is a straight wire, when the helix is stretched out until its diameter becomes zero. The multiple loop parasitic antenna and the axial mode helix when both of one wavelength in circumference exhibit equivalent gain when the boom length is less than about ½ wavelength. For longer boom lengths the helix outperforms the parasitically driven antenna. For the less than $\frac{\lambda}{2}$ boom length, the greatest differences apparent between the two antennas are that the helix has a bandwidth of almost 1.7 to 1 of the design wavelength (much broader than the loop) and the loop has a better front to back ratio than the helix.

The helix requires a ground plane of 0.8 wavelength diameter behind it to be really effective. If one considers use of the helix for 14 MHz a ground plane 56 feet in diameter becomes a real structural problem for the amateur. The parasitic loop beam antenna uses a reflecting loop instead of the ground plane and is somewhat easier to build.

The writer, in extrapolating axial mode helix data for the one-wave-length pitch circumference helices and comparing it with various data for performance of parasitic beams, concluded that a four-element parasitic loop antenna using loops of one-wavelength in circumference and a boom length of 0.4 wavelength should turn out an honest 10.5 dB gain as compared to an isotropic radiator or about 8 dB more than a dipole. A boom length of 0.4 wavelength at 14 MHz was therefore adopted as meeting the design criteria. This boom length is 0.2 wavelength at 7 MHz and is satisfactory for a two-element folded dipole beam having a gain of about 3 dB over a dipole.

Element apertures, gain and radiation resistance

Many amateurs are aware that the gain of an antenna is proportional to its "capture area," (also called aperture, intercept area, or cross section). Apertures and gain of several element configurations are tabulated in Table 1 together with radiation resistance. In comparing antennas or antenna elements it is well to bear in mind that as the radiation resistance of the antenna increases, the power radiated to a distant point as opposed to the power stored as a space charge around the antenna increases. If one were to select a beam antenna element from only the data of Table 1, the 1½ wavelength loop would be the logical choice; however, the 1½ wavelength loop for 14 MHz on a 28 foot boom requires a clear turning area of 23 feet which is more space than many of us have available. The turning radius criteria of 17 feet incidentally resulted from consideration of space available on an average metropolitan area lot to swing a beam without invading neighboring air space or encountering obstructions when working with it on the tower.

Square vs triangular loop

The question arises: How do the triangular and square loops compare in performance? Table 1 shows that the triangular loop of one wavelength periphery has 96.5 per cent the gain of the square loop. Comparison of the patterns and gain of the two loops on near and DX signal reception over a six month period of time revealed the following information. The triangular loop when oriented with one triangle apex down and fed at the lower apex (horizontal polarization) has two major lobes concentric with the loop axis in the horizontal plane and broadside to the loop plane. Since it is a single loop, it radiated in two directions like a dipole and it has two main lobes in each of these directions about 20° off the loop axis. When oriented with one apex of the loop-up and fed either at the top apex or the center of the lower horizontal leg of the triangle (horizontal polarization) one broad lobe can be detected at right angles to the loop plane in two directions. This pattern is similar to a dipole.

The square loop (horizontally polarized) exhibited two lobes in the horizontal pattern about like the triangular loop oriented with one apex down. Los Angeles stations about 10 miles away could be completely nulled with either the single, square or triangular loop, although the triangular loop seems to be slightly better than the square loop in front to side ratio and also slightly broader in pattern than the square loop. One other point of interest was noticed and that is that the triangular loop is better than the square loop on QSB when oriented with one apex straight up.

The diamond configuration square loop and the triangular loop were also mounted

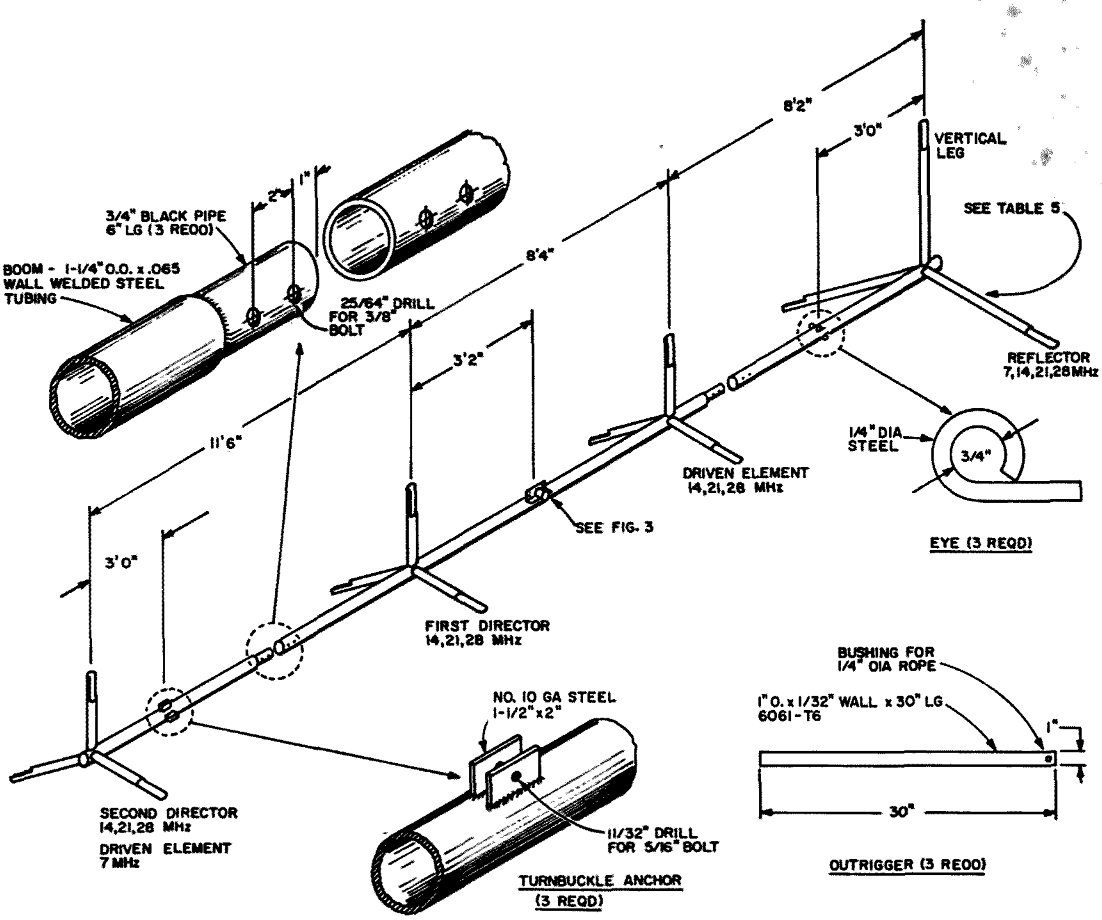


Fig. 2. Outrigger Boom Details

on a tilting fixture and gain was measured at various angles of inclination of the plane of the loop to the vertical. The tilting operation originated from a desire to see if the one wavelength diamond loop really acted like a rhombic as has been hypothesized in some diamond quad articles. It does not from the author's measurements. The effect of tilting up or down from an initial position with the loop vertical is to decrease the low angle radiation of the antenna because the horizontally radiating aperture is decreased. Also, the one wavelength diamond loop is not a uniform traveling wave antenna like the rhombic or the helix; it is simply a resonant, standing wave radiator and its gain over a dipole results from the larger aperture of the one-wavelength of wire (see Table 1).

Wind loads

The primary structural load on the multiloop beam is wind force. For practical design purposes the wind force on an antenna or tower is given by:

$$F = (\nu)^2 C_d \, A/391$$

Where: F = wind force on structure in lbs

ν = wind speed in mph

C_d = drag coefficient which should be taken as 1.7 for amateur antennas or towers

A = Area in square feet of antenna in a vertical plane (that is at right angles to a horizontal wind force)

Using an 85 mph wind criteria for the antenna yields a force per square foot of vertically disposed antenna area of:

$$F = (85)^2 \, (1.7) \, (1) \, / \, 391 = 31.5 \text{ \#/sq. ft.}$$

Wind loads for various wind velocities are tabulated on Table 6.

Antenna boom design

Three commonly used designs for beam antenna booms are (in their order of increasing complexity of construction): (1) the self supporting type fabricated from

TABLE I
ANTENNA PARAMETERS

Antenna Element	Effective Aperture (Square Wavelengths)	Directivity *	Gain Over Isotropic Source (DB.)	Radiation Resistance (ohms)
Isotropic Source	0.08	1.0	0	
½ Wavelength Linear	0.13	1.64	2.15	73
1 Wavelength Linear	0.142	1.8	2.55	93
1½ Wavelength Linear	0.158	2.0	3.0	106
½ Wavelength (Open End) Folded Triangularly	0.126	1.59	2.0	75
1 Wavelength Triangular Loop	0.145	1.83	2.63	140
1½ Wavelength (Open End) Folded Triangularly	0.2	2.51	4.0	110
1 Wavelength Square Loop	0.147	1.86	2.7	140

* Directivity = Maximum effective aperture divided by maximum effective aperture of isotropic source. An isotropic source is one which radiates power equally in all directions.

6061-T6 aluminum or mild steel tubing; (2) tubing strengthened with outrigger tension members consisting of solid rod, steel cable or nylon rope and (3) the truss. As an example of strength of the tubing boom and of the wind forces which are exerted on the loop antenna, a two-element quad on a 10 foot boom of 1.5 diameter x 0.058 wall steel tubing is stressed to the bending point of the material (elastic limit) in a steady state wind of 60 mph (calculated).

In section 3.0 it was stated that a 0.4 wavelength long boom is required for a four-element loop antenna to achieve the 8.0 dB gain stated in the design criteria of section 2.0. At 14 MHz the 0.4 wavelength is 28 feet. Applying the wind load of 31.5 lbs/sq ft for an 85 mph wind to design of a 28 foot long steel tubing boom to support four square loops reveals that a 4 inch O.D. x 0.134 wall is required and that the antenna will weigh 190 lbs. While the tubing boom is simple to construct, 190 lbs weight is excessive for many towers, including the author's home brew tilting tower. Truss construction is attractive as a means of reducing weight because the truss places direct axial tension and compression loads on the framework members (elimination of bending loads) and thereby achieves a maximum strength to weight ratio. If one uses the triangular loop to decrease loop weight by 25 per cent over a square loop and loop wind forces by 30 per cent over a square loop, a structure such as shown in **Fig. 1** is required for a 28 foot boom. The complete antenna weighs 65 lbs. using this truss. The **Fig.** 1 structure was built by the author for this antenna as a first approach. It required 70 hours to build the boom which was forthwith completely ruined by the galvanizer when handled with a bundle of heavy tower sections. Time was not immediately available to make a second truss, therefore, the outrigger construction was utilized at a sacrifice in boom weight. The design shown in **Fig. 2** uses three outriggers attached to the boom three feet from the end so that the boom carries a combined bending and column (compression) load. This boom required 30 hours to build and the resultant antenna weighs 77 lbs. It is designed for 85 mph wind loads and an 80 lb total ice load.

Element spacing trade-offs

Any multi-band beam represents a compromise between element spacings for the various bands in terms of antenna gain and bandwidth. The basic trade-off factors are as follows:

- An element spacing of 0.12 yields maximum gain for up to three elements on the beam.
- With a fourth element added a spac-

TABLE 2
ELEMENT SPACING

	Spacing for Maximum Gain (Wavelengths)	Actual Spacing in Wavelengths 7.15 MHZ $\lambda = 137.5'$	14.17 MHZ $\lambda = 69.4'$	21.25 MHZ $\lambda = 46.2'$	28.7 MHZ $\lambda = 34.2'$
Reflector to Driven Element	0.118	0.204	0.118	0.177	0.238
Driven to First Director	0.12		0.12	0.18	0.243
First Director to Second Director	0.3		0.167	0.25	0.338

ing of 0.3 wavelength between first and second directors seems to yield optimum gain.

- As the element spacing is increased gradually over a practical range from 0.12 to 0.2 wavelength the gain drops and the antenna bandwidth increases.
- Decreasing director spacing and increasing reflector spacing from the 0.12 wavelengths optimum will reduce gain and increase front to back ratio.

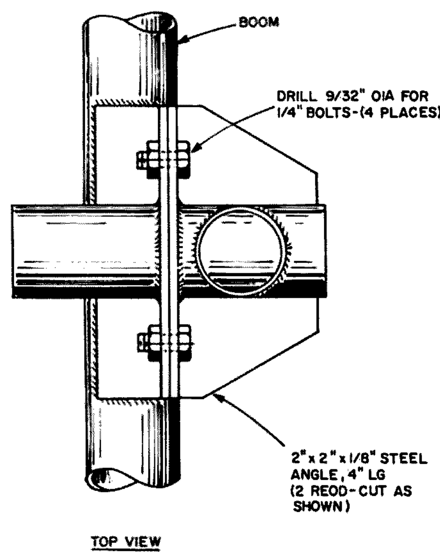
Table 2 shows the element spacing used by the author for a 7, 14, 21 and 28 MHz band *compromise;* two elements on 7 and four elements on the other bands.

Element wire lengths

Wire lengths of one wavelength driven elements can be calculated from 1 = 11800/f where 1 = length of wire in inches and f = resonant frequency in MHz.

Sufficient bandwidth for the amateur bands covered by the antenna is obtained when the reflector wire length is made 5 per cent longer than the driven element; the first director is made 2.5 per cent shorter than the driven element and the second director is made 2.5 per cent shorter than the first director.

Table 3 shows wire lengths and frequencies used by the author. Wire lengths were calculated and strung on the frames with no attempt made to tune them since the loop at its resonant frequency has very little inductance and any extraneous capacitance, introduced from measuring equipment or the human body, is sufficient to throw it off frequency. The accuracy of the wire length formula had been checked previously in building the single loops and the wire length variations for reflector and directors resulted from tabulation of much



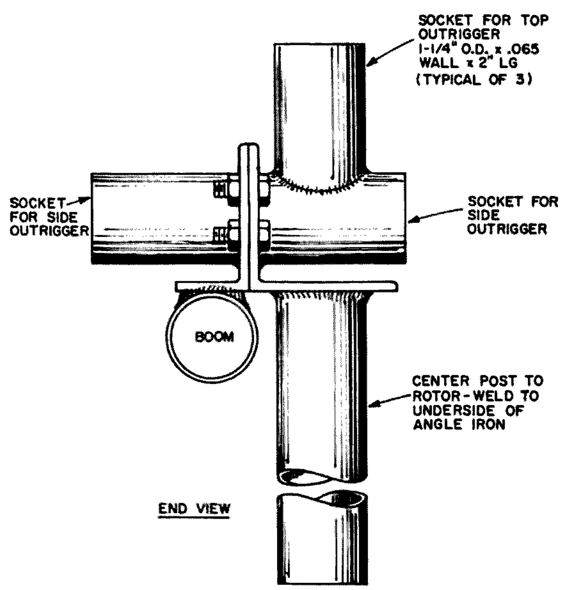


Fig. 3. Center Post To Boom Construction

TABLE 3
WIRE LENGTHS IN INCHES

Element	Frequency-Band			
	7.15 MHZ Dipole	14.17 MHZ Loop	21.25 MHZ Loop	28.7 MHZ $\frac{3\lambda}{2}$ Folded
Reflector	846	883	582	635
Driven	806	833	555	602
1st Dir		812	541	586
2nd Dir		792	528	572

data by others. The two 7 MHz elements are not loops; they are ½ wavelength wires folded into an equilateral triangular shape. The 7 MHz antenna uses the two end spiders on the boom. The 14 and 21 MHz antennas use one-wavelength loops and the 28 MHz antenna uses 1½ wavelength wires folded into an equilateral triangular shape with the upper ends separated. A 6 inch spreader is needed between legs of the 7 and 14 MHz wires on the two end elements to keep them separated; ¼ inch diameter lucite works well.

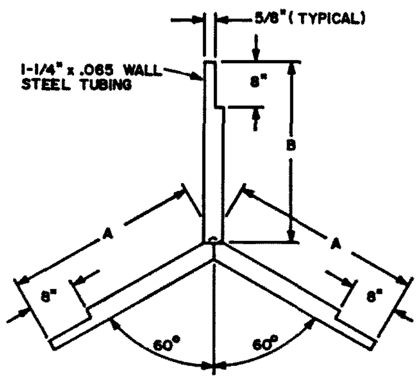


Fig. 4. See Text.

Feed point impedances

All driven loops of the antenna are fed at the center of the bottom, horizontal wire. Dependent upon height of the antenna and proximity to surrounding objects, impedances of the antenna will be found to be close to the following: 7 MHz-45 ohms; 14 MHz-50 ohms; 21 MHz-80 ohms and 28 MHz-55 ohms. Many methods of feed have been published and will not be repeated here. One fact is very pertinent concerning feeding loop antennas; that is, in relation to nearby sources of RF interference the loop will respond only to the magnetic component of the interfering field *if it is balanced.* (That is, it will not respond to the electrostatic field and will therefore pick up less interference with balanced feed.) The feed system used by the author uses double shielded 125 ohm twin lead coax from the transmitter to an antenna switch at the top of the mast. The switch completely isolates those antennas not in use. The 75 ohm, twin lead ¼ wavelength lines (not shielded) run from the antenna selector switch to the 7, 14 and 28 MHz antennas. A ¼ wavelength line from the switch to the 21 MHz driven loop is formed from three pieces of 300 ohm TV lead in parallel which yields a 100 ohm section. Lengths of the ¼ wavelength matching sections from the antennas to the switch are: 7 MHz–24.75 ft; 14 MHz–12.32 ft; 21 MHz–8.21 ft; 28 MHz–6.08 ft.

The above method of antenna feed results in close matching across the bands, a low SWR and the feed to the antenna is balanced for low noise reception of DX signals. If an antenna switch is used, it is important that it switch both sides of the transmission line completely isolating the driven elements not in use. Switching of one wire, such as the center conductor of unbalanced coax with all of the shields of the coax antenna feed lines remaining connected, results in degraded performance over complete isolation.

Construction notes

Both the truss boom of Fig. 1 and the outrigger boom of Fig. 2 are constructed

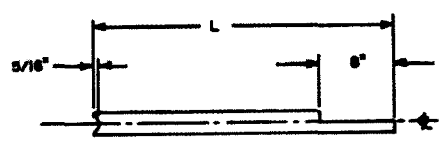


Fig. 5. See Text.

in three pieces for ease of handling, galvanizing and assembly of the wire on the frames. The center post used can be any size suitable to match your rotor or extension mast. The $1\frac{1}{2}$ O.D. x 0.065 wall low carbon tubing shown in **Fig. 1** is only strong enough to extend six inches from the rotor and still meet the 85 mph wind load design criteria. The spider construction for both types of boom is shown in Tables **4** and **5.** The $1\frac{1}{4}$ O.D. x 0.065 wall tubing used for the spider is cut back for 8 inches along the tubing center line to receive the fiber glass arms which are fastened in place with two hose clamps per arm.

The detail of the center post to boom construction of the outrigger boom is shown in **Fig. 3.** The outriggers are 30 inches lg. 6061-T6 aluminum as shown in **Fig. 2.** The outriggers fit loosely in the sockets of **Fig. 3** so that the outriggers will not be loaded eccentrically. A $\frac{1}{4}$ inch diameter nylon rope is used for tension members and it slides through the bushings in the outriggers. The author made the bushings of nylon, but they can be any non-rusting material. One $\frac{5}{16}$ inch turnbuckle is used in each tension member, positioned at one end of the boom for a tilting tower or the center of the boom for non-tilting towers. All stainless steel hardware was used by the author except for the aluminum turnbuckles.

TABLE 6

Wind Velocity (MPH)	Horizontal Force on Antenna or Tower (Pounds psf)*
30	3.9
35	5.3
40	7.0
45	8.7
50	10.9
55	13.3
60	15.7
65	18.4
70	21.3
75	24.3
80	27.8
85	31.5

*Take area as largest cross section of member. For example, tubing cross section equals diameter x length.

Advantages if this antenna can be summarized as follows:

- It provides a four-band rotary beam capability.
- Directivity and discrimination against rear and side signals is excellent on all bands. Front-to-side ratio better than the quad and gain is equivalent.
- It is less susceptible to QSB than the square loop.
- Cost of arms is reduced along with antenna weight and wind load area over the square loop.
- Appearance is good.
- It will stay up.
- If fed with a balanced line, it is very quiet on reception.

Disadvantages are:

- It requires 1.3 feet more turning space (radius) than the square loop (with 28 foot boom).
- It is more sensitive to interference between ground and sky waves than a plain wire. (Also true of the square loop.)
- Hams will knock on your door and tell you that part of your quad has fallen off.

. . . W6DL.

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Terman, Electronic and Radio Engineering
Langford Smith, Radiotron Designers Handbook
Jasik, Antenna Engineering Handbook
Henney, Radio Engineering Handbook
Editors and Engineers Ltd, The Radio Handbook
I.T. and T. Corporation Reference Data for Radio Engineers
Numerous foreign and domestic papers

The Selcal

An RTTY character recognizer

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Yardley, Pa. 19067

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Mansfield, Ohio 44907

The Selcal is sort of an electronic stunt box. It receives RTTY characters directly from the loop, with no machinery running. It recognizes four (or more) characters, in the proper sequence. An output relay closes to turn on your printer or other device. It then recognizes receipt of four letters "N", sent at the message end, to turn off your printer. While the characters must be received in the proper sequence, the Selcal does not distinguish between upper and lower case. Fig. 1 shows how the Selcal is hooked up.

The basic system is very versatile, and will be the basis of further RTTY logic systems such as regeneration, series-to-parallel conversion, and speed conversion.

The system is digital, using inexpensive Motorola integrated circuit (IC) logic blocks. This logic is designed to operate in practically any combination, with voltages, switching times, etc., figured out for you, eliminating much circuitry detail. Best of all, they work! Their cost is far below even junk box prices.

Logic

The Selcal is built entirely of three types of logic. Each will be described to allow the reader to follow the Selcal operation. See the reference list at the end of the article for more information on logic. This logic series operates on two voltage states: high (H) voltages—over 0.8—will turn on any gate; low (L) voltages—under .43—insure all gates are off. Levels between .43 and 0.8 would give erratic operation and are not used. The logic symbols do not show the B+ (3.6v) or ground connections.

Inverters

The simplest type of logic is the inverter, shown in **Fig. 2.** This is just a resistance-coupled amplifier designed so that in the "on" state the output is less than 0.43 volts.

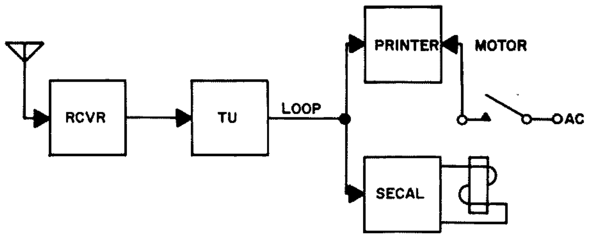
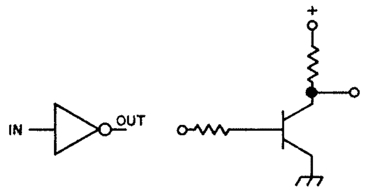


Fig. 1. Connecting the SELCAL into your RTTY system to turn on your printer when your call letters are received.

The inverter has a small "logic gain," or fanout, meaning one stage will drive several succeeding stages. A buffer is similar to an inverter but has a greater fanout capacity, and is available in both inverting and noninverting circuits. The MC789P Hex Inverter contains six independent inverter stages for only $1.08!



IN	OUT
H	L
L	H

Fig. 2. Inverter logic.

Nor Gate

The next logic type used is the nor gate, shown in **Fig. 3**. It is obvious that if any input is high, a transistor will be saturated and the common output will be low. Only if *all* inputs are low can the output be high. The nor gate is a most universal function, and nearly all digital computer circuits and systems can be built from combinations of this logic type. In the Selcal we will use the nor gate as a coincidence recognizer. With varying high and low signals on all inputs, there will be an output only at the instant all are low.

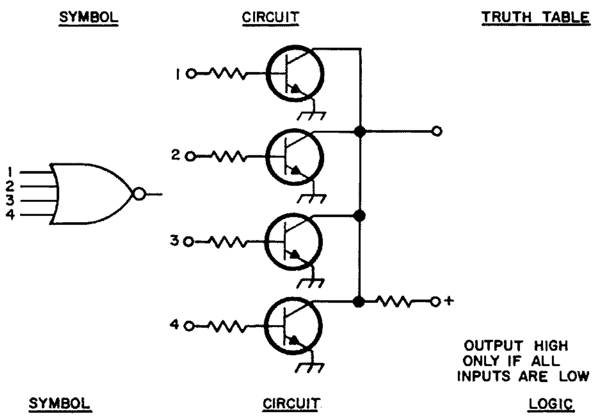


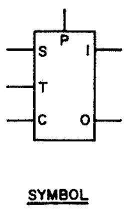
Fig. 3. Nor gate.

Flip-flops

The J-K is an unusual but most versatile type of FF used in modern digital systems. It is also called a "master-slave", or "clocked" flip-flop. Its symbol and operation table are shown in **Fig. 4**. The inputs are: Set (S) and Clear (C) (sometimes called the J and K inputs), toggle or trigger (T) and preset (P). The outputs are (1) and (0), sometimes designated as ($\overline{Q}$) and (Q). These outputs are *always* in opposite logic states; that is, when one is high the other is low. The preset function is not shown in the truth table. When the (P) lead is high, the (1) output is forced low, regardless of the states of the other inputs. While the integrated-circuit J-K contains the equivalent of 15 transistors, two independent circuits are contained in the Motorola MC790P for only $2.00.

The J-K can be connected for several different logic functions. **Fig. 5A** shows the J-K used as a common binary counter, or divide-by-two circuit. This divider will be used to count down the oscillator frequency in the Selcal.

Fig. 5C shows the clocked flip-flop operation. For this use the (S) and (C) inputs must be in opposite states, so an inverter is used as shown. The output logic states duplicate the input states *after the clock pulse*. This FF is seen to be timed, or "clocked." It will be used in this mode in the Selcal Shift Register. The truth table in **Fig. 4** shows all modes of operation.



*STATE AFTER TRIGGER PULSE

S	C	(1) *
H	L	H
L	H	L
L	L	REVERSES
H	H	NO CHANGE

TRUTH TABLE

Fig. 4. J-K flip-flop

Basic operation

The Selcal is basically a series-to-parallel converter. The five character-information pulses, mark or space, are briefly stored in a five-stage shift register. The desired character is recognized by a coincidence circuit. The state of recognition is stored in a flip-flop. When all four characters

have been received, the output relay is closed.

Lets see how the register stores the letter J, which is Start-M-M-S-M-S-Stop. The first logic level seen by the register is the start pulse, a space. This (L) input is inverted to a (H) and applied to SR 5 lead (S). After the clock pulse, the (1) output also becomes (H), which we will define as the space condition of the flip-flop. The next signal pulse (one), is a mark, which makes SR 5 lead (S) low. The next clock pulse now does two things. At this point SR 4 sees the space condition of SR 5 and duplicates its output, making SR 4 (1) low. The start pulse has been passed from SR 5 to SR 4. Also the output (1) of SR 5 is changed to high, following the input signal. At the next clock pulse, the input is a mark (pulse 2). After this clock, SR 5 and SR 4 are in a mark condition, SR 3 in a space. The shift register now contains the start and first two information pulses of the letter J. These pulses continue to enter the register from the left. Finally the start pulse is pushed out the right end of the register, which then contains all of the five J information pulses.

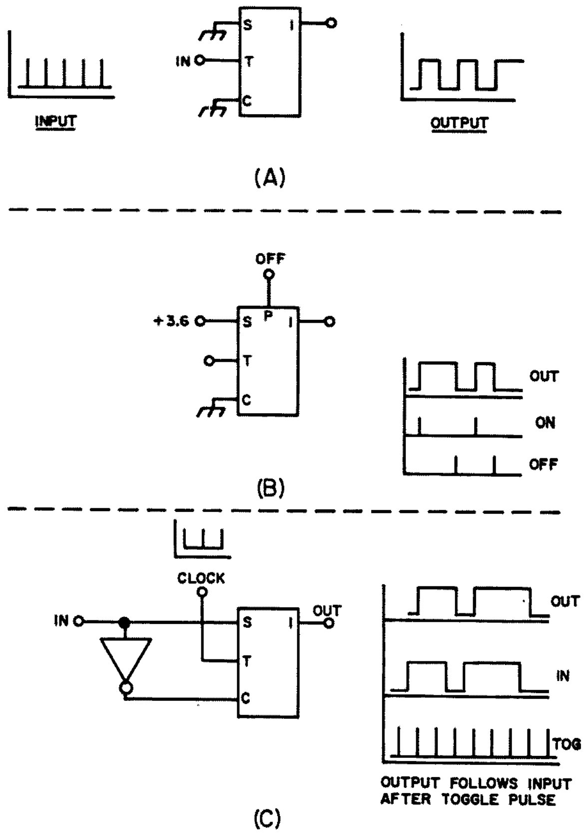


Fig. 5. Applications for the J-K flip-flop. A J-K divider is shown in A; a set-reset flip-flop in B; and a master-slave or clocked flip-flop in C.

Since both (H) and (L) outputs are available from each SR stage, we can select that lead of each SR that is low for a J. Only for this J (upper or lower case) will the all-low coincidence exist. These selected low outputs are now fed into a nor gate. Recall that the output of a nor gate goes high only when all inputs are low. It is the nor gate that actually recognizes the J. The high pulse output is fed into a character-1 FF, that flips and thus remembers that the J has been received. See **Fig. 7.**

To detect the next call letter, say K, another nor gate is independently connected to the SR outputs that will give all lows with a K. The output of the character-1 FF feeds a low to the character-2 nor gate so that the first character must be received before the second gate may look for its letter. This prevents the Selcal from responding to your call letters in an incorrect order.

When both the J and K have been received, the third nor gate is free to look for the third letter, say L. When received, the third gate gives a high output which turns on the print FF and the print relay. The printer is now on and receives your message.

To turn your machine off, the sender ends the message with "NNNNN". The letter N is recognized just like the J, with a properly connected nor gate. The gate feeds a two-stage binary counter which turns off the print FF when four N's are received.

The Selcal circuit is complicated by the lack of the exact logic needed. Several nor gates are paralleled to get enough inputs, and buffers and inverters are used to increase fan-out or driving power. Note that the A-B signal lines carry the same pulses, the split being just to prevent device overload. The abbreviations listed in Table 1 will be used in the following detailed discussion of operation.

Selcal operation

Turn on

At the beginning of a start pulse, a high occurs on the m-s line, setting the start FF (**Fig. 8**). In this "set" condition, the start FF places a low on the divider preset leads, allowing them to operate. The oscillator inverter raises the voltage on the 6.8 k resistor to high, starting the clock oscillator.

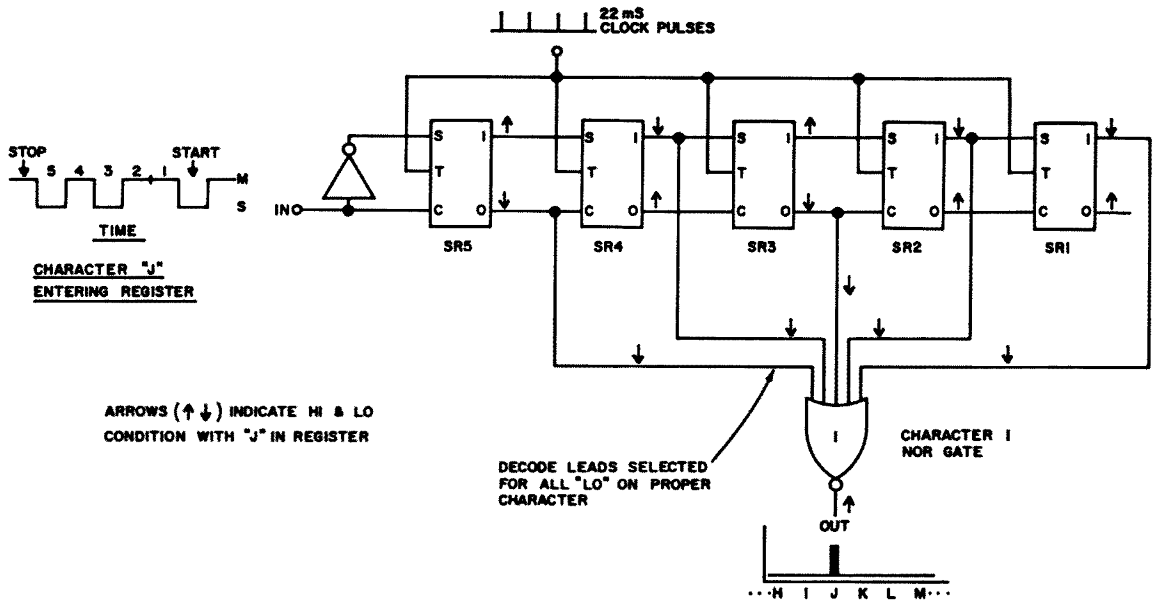


Fig. 6. A shift register connected to provide an outputwhen an RTTY letter "J" is applied to the input.

The clock is a multivibrator that generates 5.5 ms (181-Hz) square waves as shown on line 2, Fig. 9. These pulses are divided by two, five times, by the dividers D1-D5. These waveforms are shown on lines 3-7 of Fig. 9.

Recall that a nor gate has a high output only if all the inputs are low. By properly selecting the clock and divider outputs, a set of low leads can be found for each single clock pulse. As an example, lets see how the single decode pulse is obtained. At the decode time, (line 11), D2 and D3 leads (1) are low, but D4 and D5 leads (1) are high. By selecting the (0) leads of D4 and D5, we obtain all low inputs for the decode gate. D3 is not needed. Only at one particular time will the above conditions exist, so the decode nor gate gives an output pulse only at the proper decode time.

In this way, nor gates connected to the divider outputs produce properly timed set, shift, and end pulses. The end pulse resets the start FF, ending the Selcal sequence for one character. The "reset" start FF stops the clock oscillator and presets the dividers, making them ready for the next operation. The *hit* gate looks for a spacing signal partway into the start pulse. If a mark exists at this time (non-RTTY signal), the hit gate resets the start FF, terminating the operation. This resets the circuit after a false start from noise. The set-shift-not gate suppresses unwanted set and shift pulses.

Now back to Fig. 8. Assume the call K8ERV is being received. To prevent casual copy reference to "ERV" from operating the printer, the code will be "ltrsERV", which already exists in the callsign. The first character "letters" (ltrs) enters the shift reigster as described earlier. At the time of the decode pulse, the ltrs marks and spaces are contained in the register. The C1 nor gates are connected to the five SR output leads that will give all lows. The C1 gates will now recognize the ltrs character and give a high output to the CH1 FF. This high, with the decode pulse, causes the CH1 FF to set, remembering that character one was properly received.

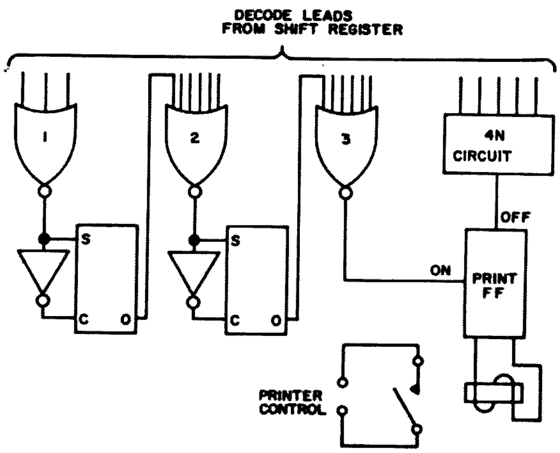
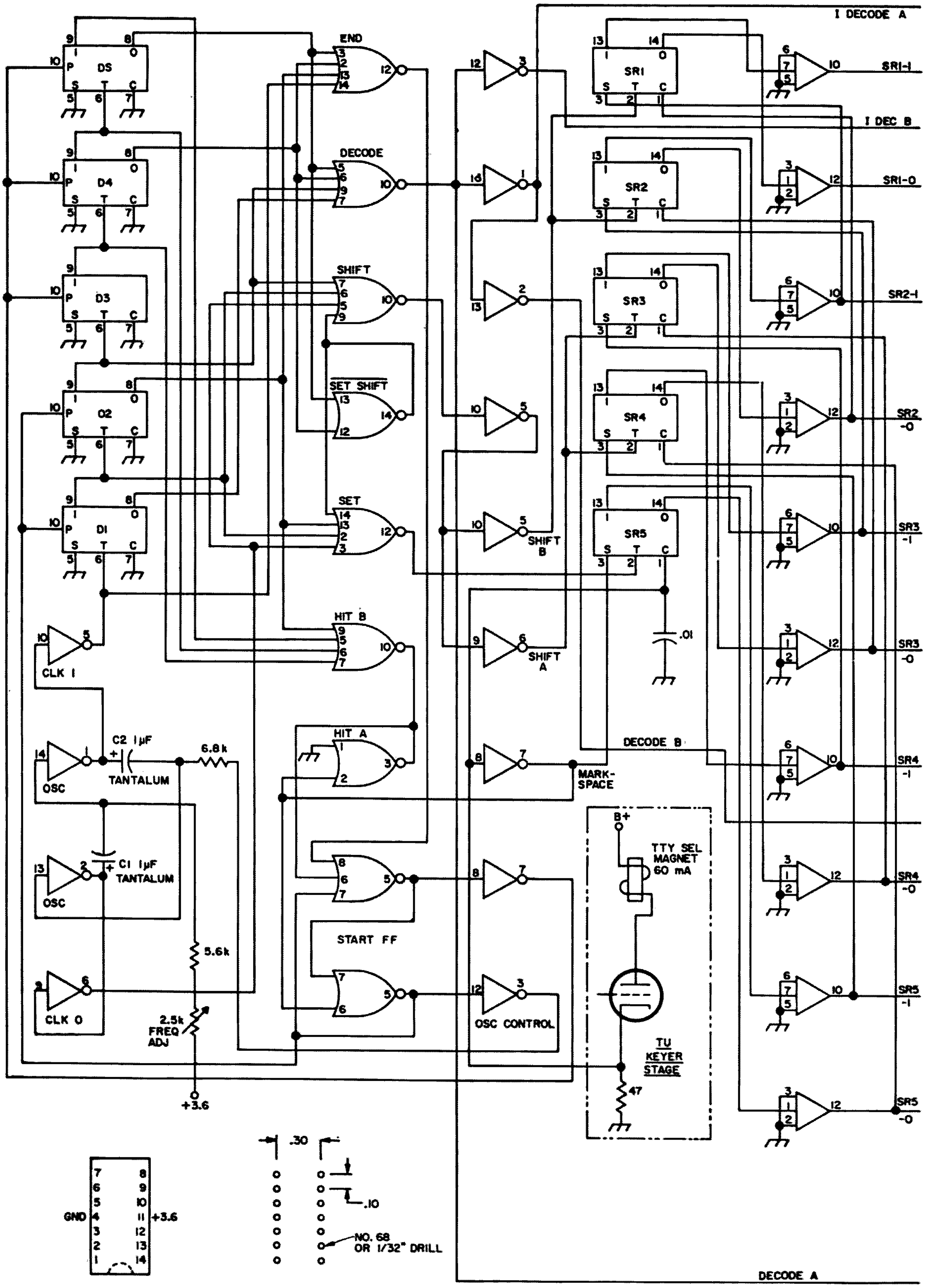


Fig. 7. The sequential selector. This circuitry is connected to the output of the shift register shown in Fig. 6 so that the letters of your call sign will turn the printer on only if they are in the correct sequence.



PIN LOCATIONS BOTTOM VIEW

DRILLING LAYOUT

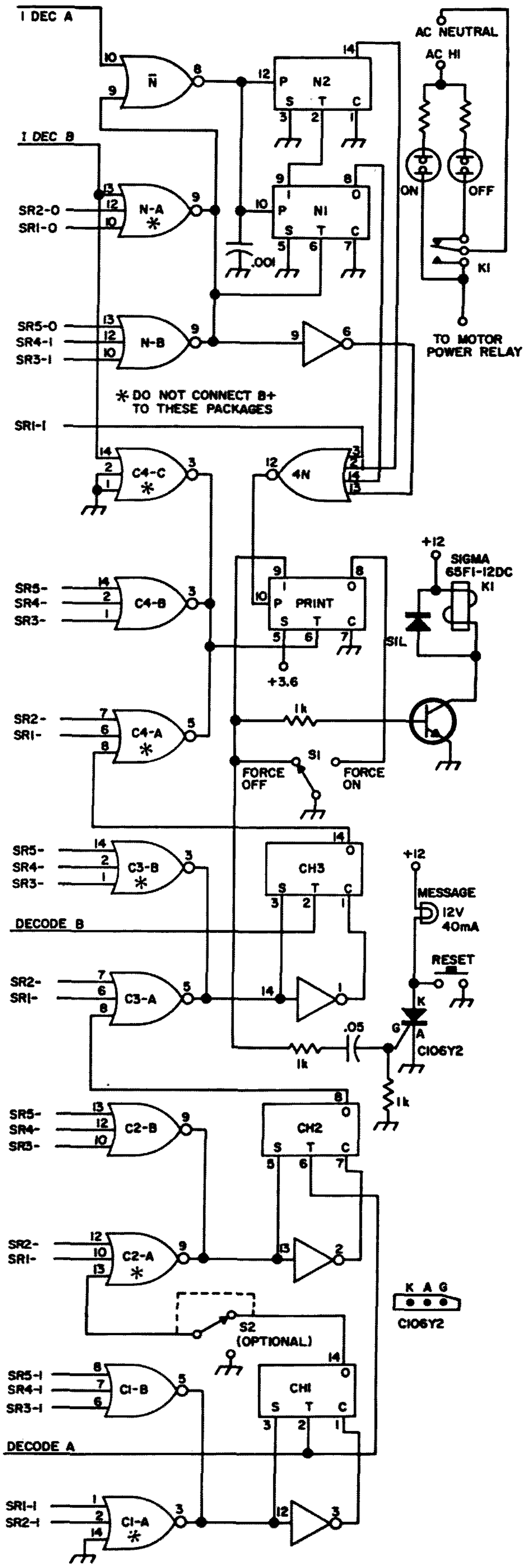


Fig. 8. Schematic diagram of the selcal. Relay K1 is a 12V Sigma 65F1-12DC. Transistor Q1 may be any high-gain silicon transistor such as the Motorola MPS3393. The message light is a Sylvania 12ES. Switch S2 is an optional "omit first character switch".

The CH1 FF low output (lead (0)) is fed to the character-2 nor gate, permitting it to look for, and recognize the next character, "E". As the decode pulse transfers the "E" recognition into the CH2 FF, it also resets the CH1 FF, which insures that characters will be recognized only in the proper sequence. The "E" makes the CH2 FF output (0) low, and the following "R" makes the CH3 FF output low. This low, plus the SR lows from the "V", and the inverted decode pulse (a low pulse) place all low inputs on the C4 gates. The high output from C4 sets the print FF, turning on the output relay and your printer. The Selcal has recognized the last four characters of the call K8ERV! Any wrong character will interrupt the sequence and reset the logic, preventing turn-on.

Turn off

The print FF will now remain on until reset by a switch or by the reception of NNNN, a commercially used disconnect sequence. This section operates by recognizing and counting consecutive "N"s. The fourth N received gives an output through the 4N gate which resets the print FF. Any character other than N operates the N-not gate which resets the FF's, destroying the count. The Selcal must see four consecutive N characters (or upper case equivalent) somewhere in a sequence, to turn off.

All-call

An important addition by KØOJV permits all Selcals to turn on with one particular calling code besides your selected call letters. Since recognition circuits exist for both "ltrs" and "N", an all-call code requiring a minimum of additional logic is "LtrsNLtrsNLtrsN". This code, besides being the easiest, will not occur in normal text. The use of six characters decreases the chance of false turn-on from noise.

Fig. 10 shows the all-call addition. This is a counting arrangement similar to the 4N turn-off, except that the sequence "LtrsN" is counted until all three pairs are received, turning off the print FF. The counter is

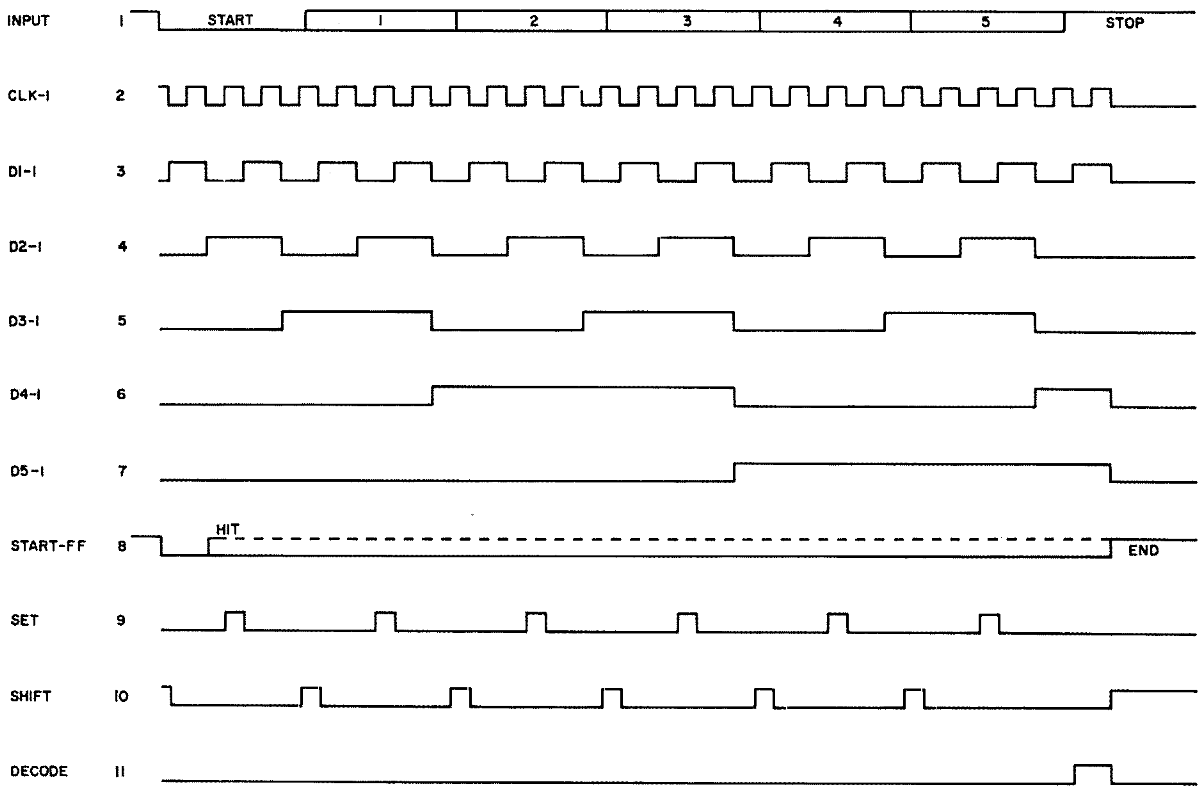


Fig. 9. Timing chart for the Selcal.

reset by any character other than "Ltrs" or "N".

Message light

This circuit can be included to lock on a pilot light when a message is received. This alerts the operator to look at the copy. The print FF output pulse is used to trigger a small SCR that locks on a low current lamp. The lamp is manually reset by a momentary, normally open push switch.

Construction

The integrated circuits used in the Selcal are the Motorola RTL (Resistor-Transistor-Logic) 700 or 800 series, in a plastic dual in-line package. These differ only in price and temperature range, the 700 types covering 15-55°C and the 800 types covering 0-75°C. Data sheets are available from Motorola.*

These logic blocks may be laid out in any order. While IC sockets are available, they are expensive and unnecessary. One way to mount the IC's is to drill holes in a plastic sheet, insert the IC leads in the holes, and wire to the pins. Another way is to mount the blocks on their backs, using an adhesive, or double faced tape, and again wire to the pins. Leave plenty of room for the wires, there are several hundred of them! The easy way is to use the pair of circuit boards from KØOJV*, at $10.00 a set, undrilled. We strongly recommend small (#26) colored Teflon wire to prevent soldering iron damage in the rather cramped wiring space. The cheapest Teflon seems

Table I

I	Inverter, or inverted.
SR	Shift register or stage.
N	Used in the 4N disconnect circuits.
C	Character; letter being recognized.
CH	Channel; memory for a character.
FF	Flip-flop.
Not	Circuit operating on all characters except ( ).
M-S	Mark-space.
Set	Pulses toggling SR5.
Shift	Pulses toggling SR4-SR1.
Hit	Non-RTTY pulses.
D	Divider stage (by two).
High	Voltage over 0.8.
Low	Voltage under 0.43.

to be the Knight brand available from Allied radio, at about 5c a foot.

The power supply must provide 3.6V ±10% at about 600 mA. The design shown in **Fig. 11** has excellent regulation and negligible ripple to about 90 line volts. Its performance is better than needed but not expensive. Z_1 is a group of forward biased diodes of any silicon type, used as a low-voltage Zener. Z_2 is optional, being a group of one-amp diodes used to limit the voltage in case of any type of supply failure. The Selcal can be operated from two flashlight batteries for testing, using a voltmeter in place of the output relay.

The power supply and front panel layouts are not critical The only controls really needed are the on and off switches, but all sorts of pilot lamps and other goodies can be added as described.

Decoding

Setting up the letters you wish to receive is done by hooking the particular character nor gates to the proper SR outputs. Character 1 is shown set up for "Ltrs". The N gates are, of course, wired for N's, although any repeated character could be used. To construct the decode chart (**Fig. 12**) for any character, replace the character marks with (1), and spaces with (0), omitting the stop and start pulses. The first information pulse (after the start pulse) will eventually be in SR1, so the chart is actually reversed from the normal character construction. Since N is S-S-M-M-S, it becomes SR1-(0), SR2-(0), SR3-(1), SR4-(1), SR5-(0). Enter your letters in rows C2, C3, C4. Now transfer this decode to the C2, C3, C4 nor gates in **Fig. 8.** C1 is done for you for "Ltrs". Connect each nor gate lead to the indicated SR output lead. The SR outputs may feed more than one nor input. This is the reason the non-inverting buffers are used.

The simplest method of decode wiring is to permanently connect the decode leads. But two other methods are more versatile.

Fig. 13 shows how twenty inexpensive slide switches can be used to set in the four characters at will. This scheme permits fairly rapid changes in the decode set. A piece of cardboard with holes that accept the slide levers in a particular decode setup can be used to check the settings.

A still faster decode change can be obtained by using a multi-pin connector as a patch board. Each decode group is wired to a separate plug and inserted into the

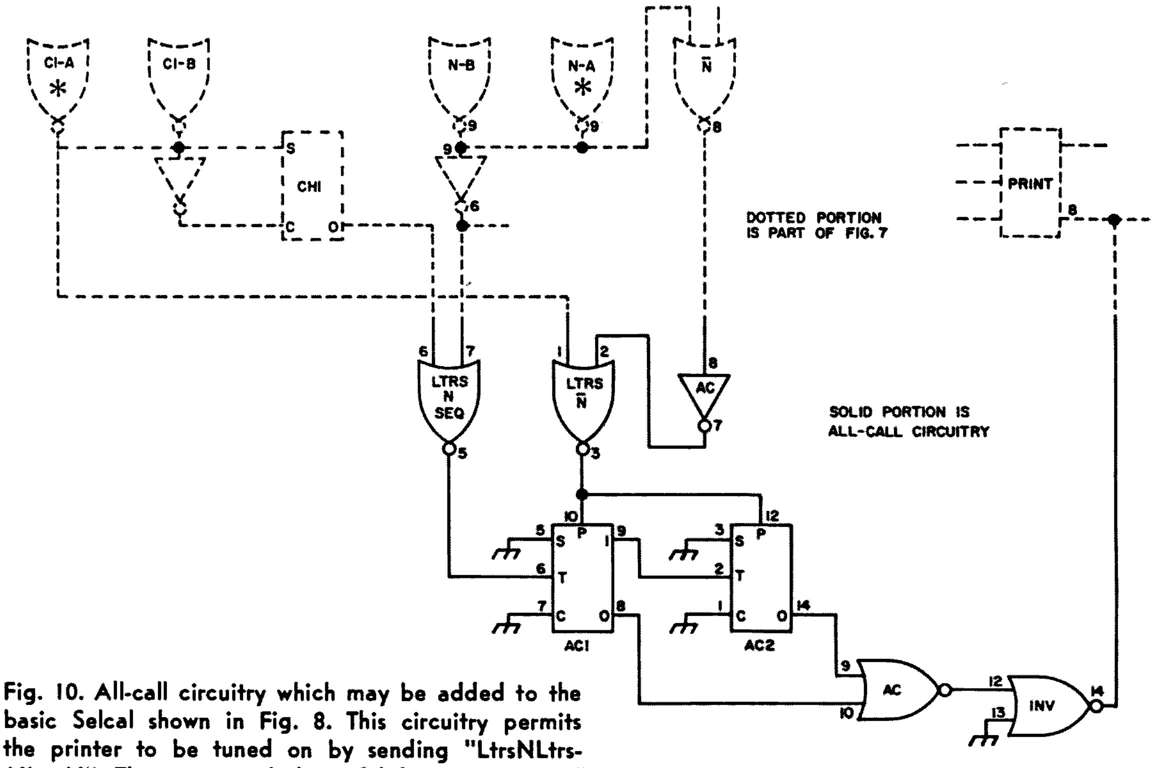


Fig. 10. All-call circuitry which may be added to the basic Selcal shown in Fig. 8. This circuitry permits the printer to be tuned on by sending "LtrsNLtrs-NLtrsN". This is particularly useful for turning on all the machines of an RTTY net.

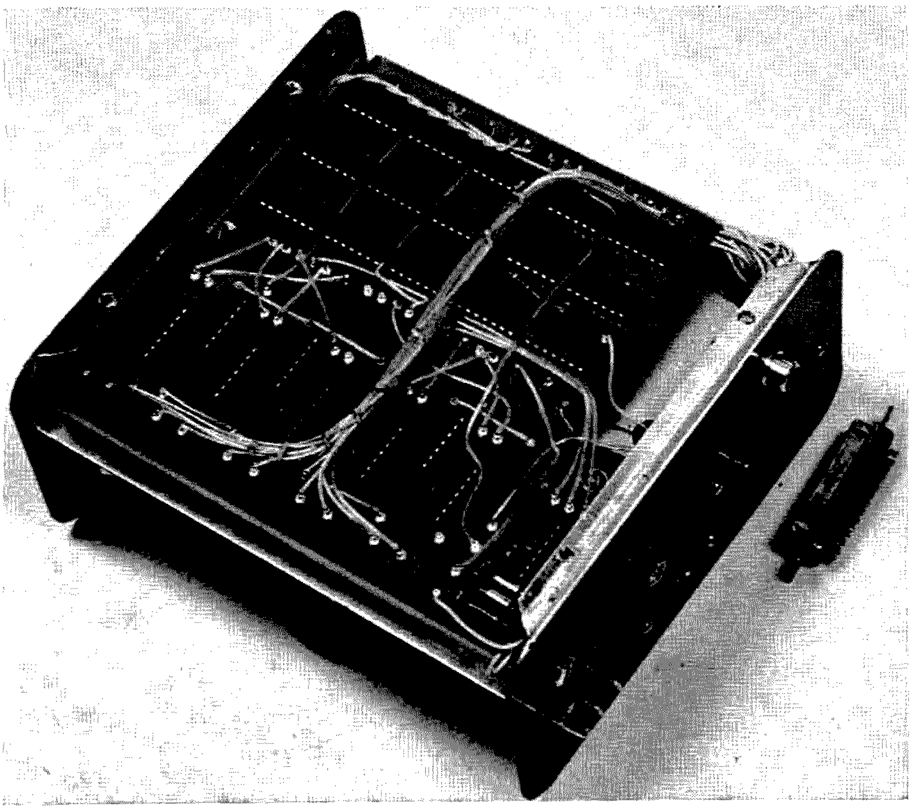
socket in the Selcal. Twenty-five pins are required for a three-letter decode, thirty pins for four letters.

The Selcal turns on the printer motor when its code set is received. If fed with continuous random noise, eventually the Selcal will receive its code and give an unwanted turn-on. A three letter decode for commercial or experimental copy can be obtained by grounding the C2 output lead, as shown in **Fig. 8**. This is not recommended for unattended copy due to the increased possibility of noise turn-on. We suggest the Selcal be teamed up with an auto-start system, such as in the TT/L to inhibit the noise fed to the input.

Adjustment

The only adjustment is the clock oscillator frequency. Temporarily turn on the clock by shorting the Selcal input. Connect a scope to either clock output. Using the line frequency for comparison, adjust the 2.5k pot for 180-Hz output. If a scope is not available, set the pot in the center of the range that gives proper Selcal operation.

The power supply output should be from 3.3 to 3.9 volts. It can be varied slightly by changing the 100-ohm resistor from 50-200 ohms. If greater shift is needed, change



Construction of the *Selcal* used by Bernie W7AHW/4. The connector and plug are used for decoding purposes as described in the text.

the number of diodes in Z_1. Caution, do not operate into the logic with Z_1 disconnected. A 6-ohm, 5-watt resistor can be used as a supply load to simulate the Selcal when "tuning up." If a Variac is available, run the line voltage down until the output starts to drop. This should be about 90 volts, but depends on the gain of the 40310. Lowering the value of the 270-ohm resistor will reduce the required input voltage, but too low a value will reduce regulation and may overload the 2N3904.

If wired correctly, the Selcal should take off when connected as in **Fig. 1.** Note that the Selcal relay will not handle a printer motor load, and must be used only to drive a suitable motor relay, such as the RBM 84-903 ($3.05).

Connect your printer into the local loop and send your call letters. The Selcal relay should turn on. If it by any chance does, you have made about 350 proper connections! Now send any letter except N, to reset the all-call, and then send "NNNN", and hope it turns off. If not, don't despair, a troubleshooting guide follows.

Troubleshooting

First check to see if the start FF and clock oscillator are being keyed. Hook a scope or headphones through a 1000-ohm isolating resistor to the Clk-1 output. Sending any letter should produce a burst from the oscillator. Ground the Selcal input and check for proper outputs from each divider and from the set, shift and decode gates,

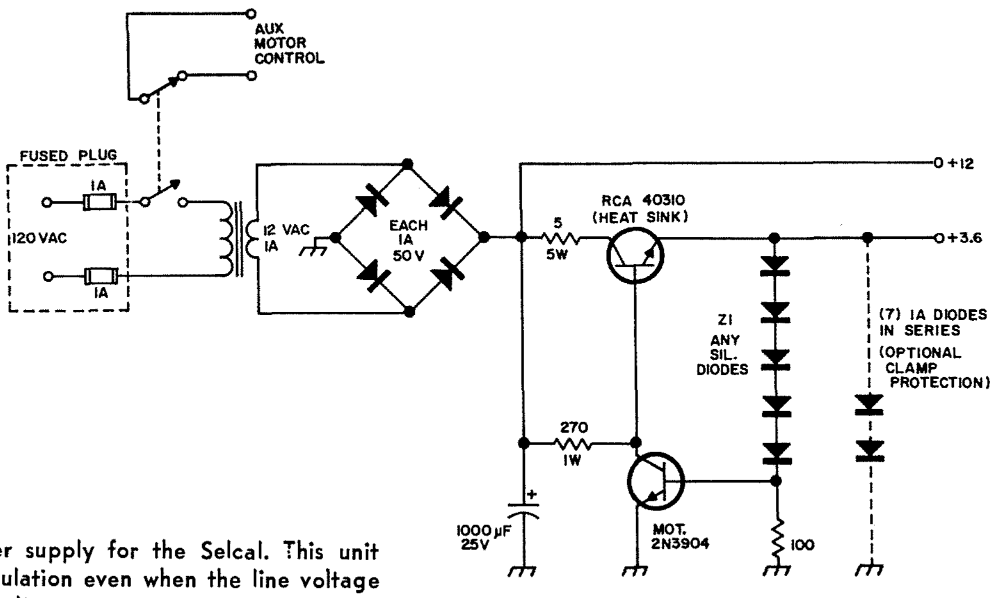


Fig. 11. The power supply for the Selcal. This unit provides good regulation even when the line voltage dips down to 90 volts.

as shown in the timing chart. Any logic block pin, except B+, may be connected to B+, or grounded, to force a circuit on or off, without harm to the logic.

Now check the shift register by sending a "letters" character. With a voltmeter see that all the SR-1 leads are low (less than 0.43 V), and that all the SR-0 leads are high (over 0.8V). Send an N and check for lows on SR3, 4-1, and on SR1,2,5-0. Any letter should leave its proper pattern in the shift register. If the higher number SR stages work, but the lower ones don't, check the wiring and logic at the point of signal loss.

Now send any letter not in your code set. A meter should show highs on all of the character FF (0) leads. Your first code character (Ltrs) should make CH1-0 go low. The second code character will reset CH1-(0) to high and make CH2-(0) low, etc.

Check the 4N gate as follows. Send any letter other than "N". All four inputs to the 4N gate should be high. The first N will place a low only on 4N pin 14. The second N should make only 4N pin 2 low. The third N will make both pins 2-14 low. During the fourth N, only at the decode time, do pins 3-13 go low, but a scope is needed to see this. The 4N gate output briefly goes high, resetting the print FF and turning the relay off. With the exception of the 4N system, most of the Selcal functions hold their states after decode, so that a voltmeter is all that is needed for testing.

DECODE CHART

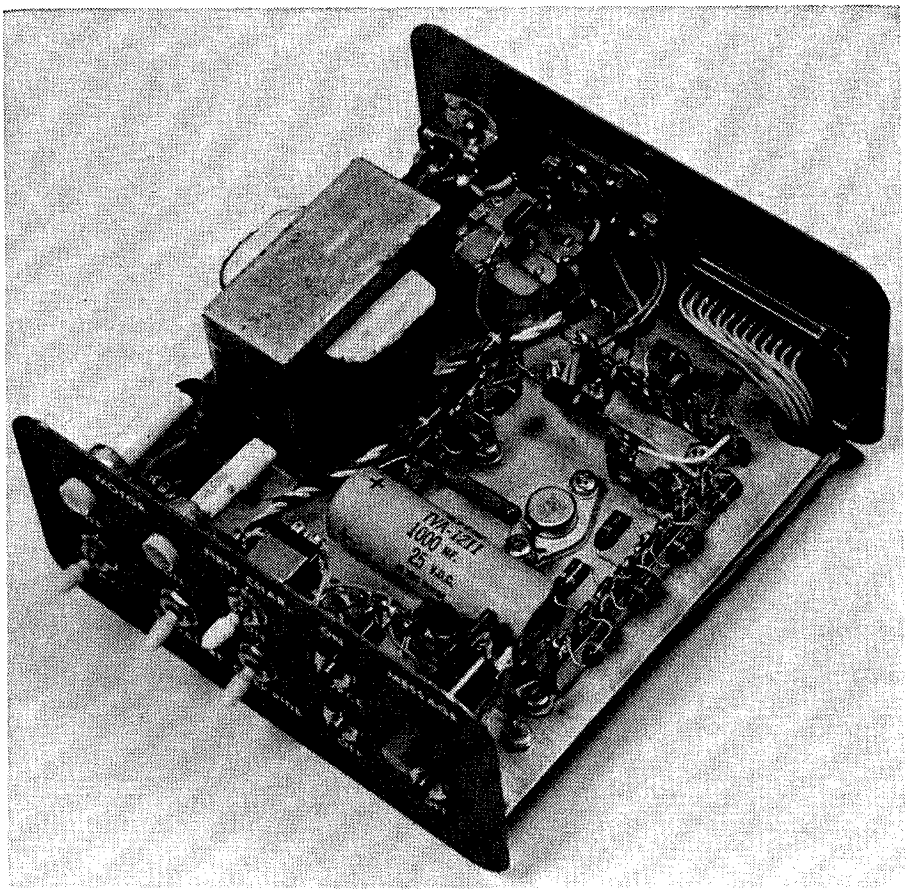
SR	5	4	3	2	1
LTRS	1	1	1	1	1
C2					
C3					
C4					
N	0	1	1	0	0

Fig. 12. The decode chart which is used in setting up the Selcal for receiving your call letters. Its use is fully discussed in the text.

Use

In operation, the receiver, tuning unit, and Selcal are left running continuously, or connected to a time clock. The sender should transmit your call several times to insure reception and turn-on. After his call, it is helpful to include the time in GMT,

Top view of the *Selcal* built by W7AHW.



followed by an extra line feed to separate the messages. After sending the message, he should return the carriage to the left, and send 8-10 N's. If conditions are poor, send extra N's to insure turn-off, any not needed will not be copied. Automatic CR-LF systems are very convenient for any unattended autostart or Selcal operation.

While autostart is not useful for monitoring continuous commercial stations, the Selcal is, and can be used to select only those parts of interest to you. However, for 75 or 100 WPM monitoring, the Selcal clock must be changed.

The RTTY Journal of January 1967 has information on the Miami Weather Station, WBR-70, on 14.395 MHz. A few hours of copy may show some particular parts of interest. Set up the Selcal to decode the appropriate heading and you are in business. For example, the Weather Satellite predictions are preceeded by "TBUS". The 4N turn-off is sent regularly.

We would like to acknowledge the help of these RTTY'ers Harold Quinn, KØOJV for his circuit suggestions, his All-Call development and his circuit boards; Tru Boerkoel, K8JUG for parts list and kit he makes available on request;* and the many on the autostart net who patiently listened to the groaning birthpains of the Selcal.

. . . K8ERV, WA8PCK

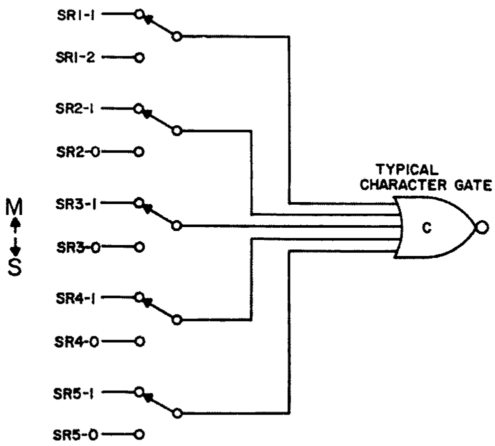


Fig. 13. By using slide switches in the input to the character gates, various turn-on codes may be used with the Selcal.

*Technical Information Center, Motorola Semi-conductor Products, Inc., Box 955, Phoenix, Arizona 85001.

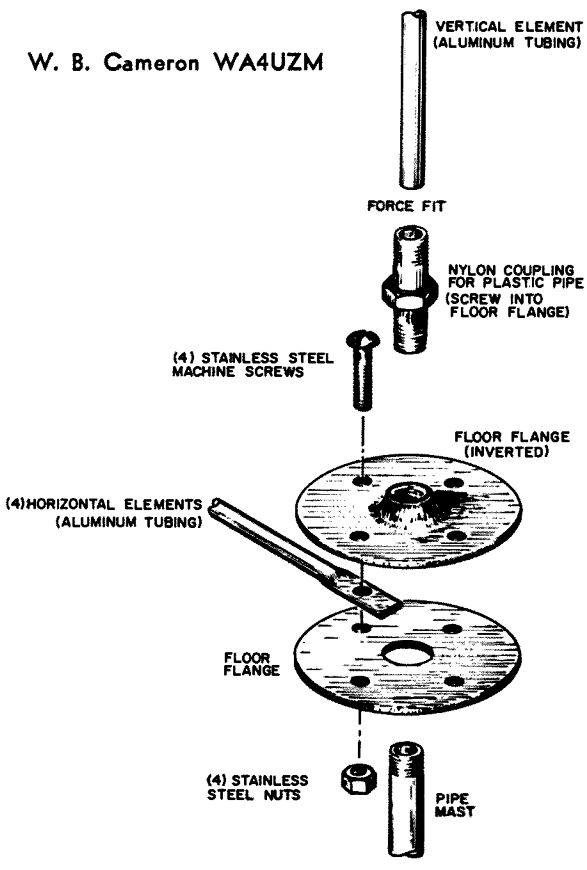
*Harold Quinn, 6605 Mardel Avenue, St. Louis, Missouri 63109.

*Tru Boerkoel, K8JUG, 195 Brandywyne Drive, Constock Park, Michigan 49321.

Hardware Store Ground Plane Antenna

W. B. Cameron WA4UZM

One of the classic vertical antennas for VHF work is the ground plane, and one of the classic problems is how to assemble it mechanically. Lacking machine tools to make special parts, this can seem formidable, but the attached exploded drawing shows how to assemble a sturdy ground plane quickly from parts available in any well stocked hardware store. The size of pipe and fittings to be used is not critical, and can be determined by what is available. For a 50 MHz antenna a reasonable size is 3/4 inch pipe and the aluminum tubing of such diameter to make a firm drive fit into the nylon coupling. For a high wind area the pipe might be a 1 inch or one could use ½ inch to make a light portable job. In addition to quick assembly this construction permits quick disassembly merely by unscrewing the pipe mast and loosening the four bolts that hold the horizontal elements in place. For optimum match to a 52 ohm line the horizontal elements may be bent down about 30 degrees. This is best checked with a standard SWR bridge.



Ken Sessions K6MVH
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ARE PHONE PATCHES LEGAL?

Probably every amateur that has connected a phone patch to his radio system has experienced the fleeting and cursory twinges of guilt that accompany each soldered connection. Or the flash of anxiety each time he sees a telephone company truck parked near the QTH.

Are phone patches legal?

Many self-respecting commercial producers of amateur radio gear include complete packaged hybrid telephone patching units in their basic equipment lines. Following a logical line of reasoning, then, an amateur might well assume that phone patches are indeed legal. None can say that phone patches are unlawful, but they're not exactly legal, either. Not quite yet.

Indications are that they will be, however—and very soon.

Not too many amateur radio operators are familiar with the little-publicized prohibitory mandate called Tariff 132, and FCC edict which gives telephone companies a broad range of freedom in rate-setting and rule-making. Among other privileges, telephone companies have the right to establish price schedules and ban "telephone attachments" and "foreign equipment" that might tend to degrade telephone performance.

The truth is, there's nothing illegal about the phone patch, itself; it's the amateur's interconnection of it that causes all the problems. If the phone company would make the connection or give a blessing to the installation *before* it is done, all would be well. The manner in which the official government ruling is written and interpreted makes it an offense to attach *anything* to a telephone or telephone circuit. Thus, as the law stands today, a busy telephone user can't even legally connect a shoulder rest to the handset.

Just what constitutes an "attachment" has been the subject of many litigations in U.S. courts. Surprising though it might be, a device may be considered an "attachment" even when there is no direct connection to the telephone or line! A case in point is the Carterfone, manufactured by Carter Electronics Corporation in Dallas, Texas. The Carterfone, a cradle arrangement onto which an ordinary handset may be placed, couples the handset audio to a mobile radio system. The device makes no electrical connection to the phone and requires no handset modifications. Yet, in 1965, the FCC advised Carter that the Carterfone device violated the provisions of Tariff 132. An FCC examiner confirmed this finding later, and held that the device was an "attachment" within the meaning and intent of the original ruling.[1]

An interesting outcropping from the Carter Electronics case was a recommendation by the FCC examiner that the Carterfone be allowed *despite the ruling*. He said the tariff was an unwarranted restriction of a telephone user's right to use his phone "in a way that is privately beneficial without being publicly detrimental." This official assertion is extremely significant to amateurs with phone patches. Many of us have been thinking that the phone patches were frowned upon because of rate-jumping, a fallout of a telephone/radio marriage.

The Carter case served to bring general reappraisal of the tariff regulations by the FCC and the Justice Department. As a result, the Common Carrier Buerau of the FCC has recently recommended that Tariff 132 be rewritten to permit wider use of telephone attachments. The recommendation was seconded by the Justice Department. The consensus was that the tariff's restrictions tended to place the telephone companies in monopolistic positions with respect to the supply and installation of peripheral telephone-dependent equipment.

The telephone companies have been plagued with their share of "monopolistic practices" problems, anyway, and probably will not be able to prepare any overwhelm-

ing stumbling blocks to a new FCC ruling on attachements. Two large telephone companies were recently under heavy fire from the Private Communication Association for unfair restraint of trade. The PCA went so far as to accuse the two giants of acting in contempt of court by "flagrantly violating" provisions of an antitrust injunction filed by the U.S. Government in the U.S. District Court of New Jersey (Civil Action 17-29, 24 January 1956).[2] The PCA complained that the telephone companies were not restricting their business to "common carrier communications service" and were engaged in leasing of intercoms, alarms, public address equipment, and similar not-too-closely-related systems.

All these events weigh heavily in favor of the FCC reversing the "no attachments" mandate, because a more liberal ruling would invite open competition from manufacturers of terminal phone devices. The way things are now, not even the phone companies can legally connect most equipment, since this takes them out of the realm of direct "common carrier communications."

So how does all this affect the amateur with his harmless little phone patch? Very profoundly! Already the restrictions on phone patches are relaxing. Telephone companies acknowledge the fact that amateurs are attaching audio patching circuits, and they are beginning to realize that these devices pose no major threat to their overall income.

One Southern California amateur (Donald Milbury, W6YAN) has been operating a fully automatic phone patch from his mobile station in conjunction with a radio repeater for years in the Los Angeles area under the cognizance of Pacific Telephone Company. He received "implied" permission, he says, when he was requested by that company to use a particular tone frequency for telephone control to avoid the possibility of interference with other telephone circuits.

An automatic phone patch is a standard telephone system (consisting of dialing and answering capability) operated from a remote location, such as in a car or from a portable transceiver. It should be noted that automatic phone patches are compatible only with FM. Levels for automatic patching must be set for 0 dB (1 mW into a 600 ohm line),

1. Staff Article, "FCC Weighs Wider Use of Telephone Attachments," Electronic Design, 8 November 1967.

2. Staff Column, "Hot Line," Communications News, December 1967.

and maintained within 1.0 dB of this value regardless of transmitting and receiving conditions. A standard as rigid as this is a little too much for AM. Telephone companies *do* get upset when audio is patched into a line at a high enough level to intermodulate with adjacent wire-pair signals. Use of FM assures a relatively constant audio level at the receiver almost without regard to the strength of the received signal.

My own remotely controlled telephone system was given FCC sanction—also by implication—when it was licensed after a detailed description of the automatic phone patch was submitted with the official application.

Today, the amateur who connects his phone patch runs the risk of a hand-slapping from his local phone company. It's highly unlikely he'll get its blessing tomorrow. But if the FCC recommendations are followed, the amateur would have the right to connect a phone patch or any other similar device as long as it proved nondetrimental to the phone's principal function; and the phone companies would be saddled with the task of "showing cause" for denial of this right.

. . . K6MVH

Amateur Radio and Public Service

During my recent visit to the Sahara Amateur Radio Operators Convention in Las Vegas two aspects of amateur radio public service were brought to mind. One of the exhibitors was a local ham club who had as a part of their display a sign obviously intended to be displayed along the highway approaching the area in which the club operates. This sign listed frequencies that are monitored by members of the group which travelling hams may use to contact someone for assistance. This is not a new idea by any means, but it is one which I feel deserves more wide-spread usage and publicity. I know there are many areas of the country in which local hams do monitor one or more frequencies for just such a purpose. It seems to me that wherever this is done it would be to the benefit of all hams to have these signs conspicuously posted on the main highways. As a further aid, I can visualize a national directory, arranged geographically, listing frequencies monitored; the purpose for this monitoring; and by whom the monitoring is done. As I visualize it, this directory would be similar in format to the ARRL Net Directory, but I think, at least in the beginning, there would not be a need for cross referencing, but merely the geographical listing. As an attempt to get this program going, I am offering through this editorial and similar information to be sent to the editors of the various amateur radio magazines to compile this information as my time and the facilities available to me permit. When the directory is ready, it will then be made available to anyone interested. I would hope that in time the preparation of this directory could be done under the auspices of an amateur radio club. I would expect that there will be a small charge for those who desire a copy, but this charge in turn should not be higher than necessary to cover the costs of publication. In any event, I will be appealing in the near future through various publications and perhaps by direct letter to some clubs, for information to be included in this directory. My only hope is that others will find this information to be of value and will see fit to co-operate with me in this venture.

A similar situation, in that it also involves public service, was also brought to mind at SAROC. No doubt those of you who read the ham magazines regularly are familiar with WCARS or the West Coast Amateur Radio Service. This is a group of several hundred amateurs, as I understand it, in the western states who monitor the frequency 7255 kHz, essentially during the daylight hours every day. They have a roll call at noon, so that the members have a chance to get together. However, the important part of their work is that by monitoring this frequency continually, they have been able to assist in any number of emergency situations which have come up. It seems to me that a similar arrangement could be extremely beneficial in other parts of the country and, again, I am going to put myself on the line as a guinea pig to see what can be developed. I feel that an East Coast Amateur Radio Service such as I have described could probably operate on the same frequency as this frequency should give reasonably good coverage up and down the eastern part of the nation while at the same time be far enough removed to avoid mutual interference with the West Coast Amateur Radio Service. If one or more services such as this were to be set up in the central part of the country, it is my feeling that perhaps a different frequency should be chosen. However, I can not do all things in all places and would hope that someone else will pick up the ball in other areas of the country. For my part, however, starting on or about February 1st, I will try to monitor the frequency of 7255 kHz at least during normal working hours and will try to institute a roll call at least once during that time.

As I was told at SAROC, one man started the West Coast version just by getting on the air everyday and having a call-up. If it can be done in the West, why not in the East as well? Those of you who are interested in this project, look for WB2QGK on 7255 at noon everyday. If I am not at work, look for me under my home call, W2CFP, at the same time. I expect to talk personally to other amateurs in this area in the hope that they will be able to assist

me in this project and I hope further that by spreading the word on the air and through publications that in the not too distant future an East Coast Amateur Radio Service will be developed that will be able to do the same good and public service that is now being done in the western part of our country.

If you are interested in working with me on either or both of the above projects, please don't hesitate to contact me either on the air, by mail, or by phone. If you know of anyone currently undertaking either of these projects, please let me know, as I have no desire to step on anyone's toes. I just want to get the job done. It is important to remember that public service is one of the basic principles of ham radio and in this day of diminishing ham population and increasing danger of losing some of our frequencies, it certainly behooves all of us who are hams to participate in whatever we can.

. . . David G. Flinn W2CFP

Excerpted from Comtact
Volume III Number 4

Tani C. Allen WA4HRX
Army Radio Station
La Plata, Maryland 20646

Microfilm Your Magazine

There have been a couple of good articles in 73 about what to do to reduce the huge pile of magazines you have on hand and to increase your chances of finding a particular article you want.[1]

But even with these fine ideas I still find myself having to look through most of the magazines to find the article I want. The annual indexes help, but even with those I still have to search a lot.

Another problem I have encountered is magazine portability. I am in the Army and move around quite a bit, four times in a year and a half. I use my magazines and other books a lot and I need them with me. I needed a way to have the information without the pounds.

I have reduced my electronics library from many pounds to a few ounces by using microfilm techniques from the TV spy shows. I get two pages of information per frame of 35mm film. Thus, a total of 72 pages of information on a 36 exposure roll of film is possible. The weight is about an ounce including the film storage can.

There are many approaches to filming your articles. The first approach is to film the individual 73's or other electronics magazines. This gets you away from the poundage but you still have the "Article, article, where's the article?" question.

I have been categorizing my articles. This method is time consuming but very rewarding in the end. It's nice to pick up a small can labled "Microfilm Vol. 1, *Coaxial Cable Handbook,* Parts 1, 2, and 3,"[2] and not have to go to three different issues to get the information. I have given a partial list of my favorite categories in Table 1.

The third idea is the least expensive and the least time consuming. You can film only the annual indexes and the indexes of the magazines of the current year. This may, as all the other methods, be kept up to date from time to time by splicing your new filmstrips to the one already started. You then have the "Where to find it" information at your fingertips. It will save you time and frustration. It is much easier to look at a short filmstrip than to go through several back issues.

Techniques

If you have chosen any of my ideas or have thought of one better, let's begin.

The first thing you need of course is a camera. Both 35mm and 16mm cameras are classed as microfilm cameras. I use a 35mm camera and get very good results.

You will need a place to work which is well lighted such as a room with a high wattage ceiling light. I use no direct light or flash on the material because the glare from the glossy pages will over expose the film. Believe me, a light meter is of no use.

I use a camera setting of 1/8 second and f stop (lens opening) 8. You will probably have to use about a half roll of film and experiment to find the correct settings for your particular camera and favorite type of film. Use only black and white film and be sure to keep a log of your shots for comparison with the negatives after developing.

Before . . . After

Next, lay a magazine on the floor or any background you choose and determine the closest distance you can get and still be in perfect focus. I can get only about 2.75 feet without a close-up lens. This is adequate

for most of your work, but a close-up lens will give you more detail with less magnification of the finished shot. If you don't have one I suggest the method used by K6UGT,[3] or if you prefer, you may order a 13 inch close-up lens from Edmund Scientific Co. for $1.10.

You will need a way to keep your material flat while photographing it or part of it may be blurred.

A tripod is very helpful in keeping a fixed focus and holding the camera steady. But it is not really necessary unless you have several articles to do at one time.

If you have a pile of magazines to photograph at one time, you will save yourself a lot of time by having all the magazines open to the articles you want to photograph before you begin.

After you have taken a roll of film you may do one of two things. You may take it to the local drug store to have it developed or you may do it yourself with a Kodak home developing kit. I prefer the do-it-yourself way. In either case you only want the negatives, no prints, and you want them in a strip, uncut. If you have microfilmed only the indexes as in the third method I described, you may want to mount the negatives in slide mounts to view with a slide projector. You can buy the mounts in a camera shop and mount them yourself. If you have several articles on film, as I do, it is best to keep them in filmstrip form for convenient filing and ease on viewing. You can get a film-strip projector fairly cheap if you shop around. As for the screen it can be anything from a white bedsheet (beware of your XYL) to a home brew microfilm reader.

Don't limit yourself to magazines. After you finish a logbook you can film it for future reference and not have to worry about sorting it. You could also microfilm your "Idea File" ("Card-boarding," Edward Burke, W6FTA, 73, April, 1967). The possibilities are only limited by your imagination.

Besides the advantages described earlier, you will find that the film will last much longer than the paper magazines. The fire hazards in your shack will be greatly reduced by using film stored in metal cans instead of bookcases full of inflammable magazines.

After you microfilm your magazines don't go in a mad rush to a trash can with them.

Table I

Volume I
Coaxial Cable Handbook, Parts 1, 2, and 3

Volume II
Integrated Circuits

Volume III
432 Mhz Equipment

Volume IV
144 Mhz Equipment

Volume V
50 Mhz Equipment

Volume VI
VHF Test Equipment

Volume VII
UHF Equipment

Volume VIII
Test Equipment (General)

Volume IX
Transistor Equipment Design

Volume X
Antennas and Antenna Design

Bind them in the binders available from 73 and store them in a safe, dry place. If you travel around as I do, store them in your in-law's garage until you settle down again. If you are real good hearted, you can donate them to your local ham club so that the newer hams can benefit from them.

I am very much pleased with my microfilm library and I'm sure you will be just as pleased with yours.

. . . WA4HRX

Footnotes

1. "Make The Most Of Magazines," Jim Kirk, W6DEG, 73, Dec., '66. "Dealing With The Information Explosion," James Ashe, W2DXH, 73, May, '66

2. "Scope Pix Trix," Fred Blechman, K6UGT, 73, March, '65

3. "Coaxial Cable Handbook," Jim Fisk, WA6BSO, 73, July, Aug., Sept., '66

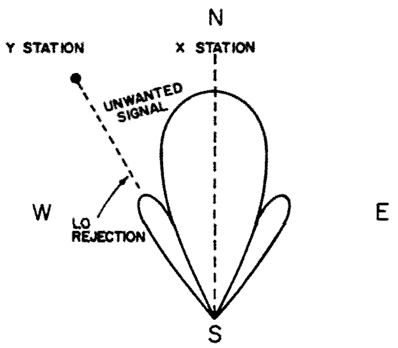
Breaking the 100,000 MHz Record

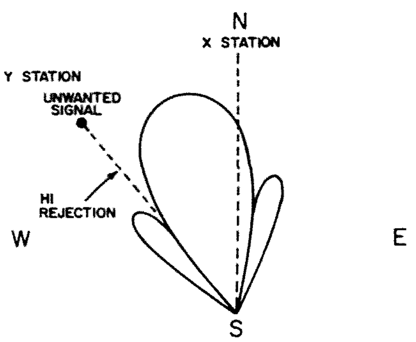
Detriments Can Be Beneficial

I think it was Will Rogers who said, "I can see some good in everybody."

If you will study the two figures in this article, you will see that deep lobes which generally appear on beams with high gain, can be used to an advantage. In Fig. 1, we are beaming a powerful signal at station X, but when we change to receive, we are getting a large amount of signal from station Y which makes receiving a bit difficult.

All we do to virtually eliminate signal Y is to turn the beam a bit to the west until that signal is in direct line with the null formed by the side lobe that is not being used. It will be noted that the signal to station X may be *slightly* attenuated, but the fact that we have, to all intents and purposes, eliminated signal Y by placing it in the null, we have actually gained more than we have lost.





This will be of the maximum good if station Y is near and very strong, and station X is weaker and further away. You are actually making the null in the beam act much like a notch filter in a communications receiver. The null is very pronounced and you can get an immense amount of rejection through this method. More important, is the fact that it doesn't cost a dime. That's pretty nice in this day and age—something for almost nothing.

. . . Bill Roberts W9HOV

Full Break-in for the Galaxy III or V

C. A. Bierbaum, WØJHD
2728 Avenue G
Council Bluffs, Iowa 51501

Since I like CW and also like to operate without having to move anything but the key; I was forced to find some way to use my Galaxy III on CW break-in.

This system has been in use for one and one-half years now and is working for me and several other people who have tried it with the Galaxy III and Galaxy V. No VOX is required as the VOX is inoperative in the CW position of the Galaxy.

No damage is done to the transceiver and the modification could be accomplished is as little as ten minutes.

On the front wafer (panel wafer) of the function switch near the top, you will find the lead coming from the push-to-talk line. Two contacts are jumpered here with the lead coming from the push-to-talk line being hooked to the contact used in the tune position. The function switch is used to ground one side of the relay in the Tune and CW positions via these contacts. If you will simply cut this jumper; the jumper can be re-soldered if original operation is desired.

When this jumper is cut; the unit will function normally except in the CW position. In the CW position all of the normal changes (including carrier shift) will be made; except that the transceiver is receiving not transmitting.

Make a jumper so that the external relay contacts can be used to complete the keying circuit.

Now with the function switch in CW; key the push-to-talk line for full break-in operation. If operation is desired or necessary where you will be zero beat with your contact, an external or Remote VFO will be necessary. The carrier is no longer shifted in relation to the receiver when you transmit. Normally this is no handicap as the difference is the audio pitch or frequency of the received CW note, which is a kHz or less.

This system is simple and works well without disturbing other functions of this fine transceiver. No abnormal wear of the relay or associated parts have been noticed after one and one half years of operation. Keying is good with no noticeable ill effects on the note. Speed is going on the relay with about fifty words per minute being about tops.

One clip (of the dikes), one jumper (via connectors on the back panel), no holes or damage, and a good time is had by all;

. . . WØJHD

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

Getting Your Higher Class License

Part II — SSB

Last time around, this study corner for the new Advanced Class examinations went into radio waves and propagation. The subject this month appears to be far different—single sideband—but the two are more closely allied than you might think.

The study-list questions dealing with SSB which we're going to examine in this instalment are:

3. What methods are most commonly used to generate single sideband signals? Draw a block diagram of the filter method showing all essential stages. How can a low frequency SSB signal be converted to the desired transmitting frequency?
7. What types of emissions can be received with selectable sideband receivers?
8. The ratio of the peak envelope power to the average power in a SSB signal is primarily dependent on what?
25. How can SSB signals be amplified with little or no distortion?
44. How does the peak envelope power input of an amplifier used for CW compare to the PEP of an SSB amplifier when using the maximum legal dc power?

Just as we did before, let's re-phrase those five specific questions into five more general questions which will include the original ones as well as most of the possible variations.

Perhaps a bit obvious, but still the best starting place, is the question "What are sidebands?" Next in line comes the more specific one which will fence in our subject matter: "What is meant by 'single sideband' signals?"

Once we are reasonably sure we understand what a SSB signal is, we're ready to ask "How are SSB signals generated?" By this time we will have definite answers for questions 3, 8, and 44. Two more questions —"How is SSB transmitted?" and "How is SSB received?"—will wrap the subject up neatly.

At the beginning it must be emphasized that the discussion here is not intended to be exhaustive in detail; many times the available space would be required for that. It will, however, more than suffice for the examinations—and, if you're interested, will set you off on the track of those not-yet-fully-answered exhaustive questions.

What Are Sidebands? Before we can begin to answer this question, we must define several other terms—such as "audio". Anything our ears can perceive comes to us as sound waves in air at audio frequency. These sound (pressure) waves correspond to electrical waveforms of the same relative intensities and absolute frequencies. An electrical sine-wave applied to a loudspeaker produces a "pure" audio tone.

Most sounds are not sine waves of air pressure, and so their corresponding electrical waveforms are not sine waves either. A somewhat advanced mathematical theory says, however, that any waveform which is *not* a sine wave can be proved to be identical with one composed of many different sine waves. Because of this, and the fact that it's not hard to deal with sine waves mathematically but next to impossible to deal with any other representation of the waveforms of sound, communications engineers for several generations have spoken of sound in terms of the *band* of sine waves represented in the Fourier equivalent of the actual sound waveform.

The audio-frequency band, for most adults, ranges from a low end between 15 and 50 Hz to a high end between 10 and 20 kHz. Most of the actual sound energy is concentrated in the frequencies below 1 kHz. More than 20 years ago, researchers in acoustics discovered that speech could be transmitted accurately within a band ranging from 300 to 3000 Hz; this is now considered the "normal" speech bandwidth.

Radiotelephone transmissions of any type, however, do not try to transmit these audio-frequency waveforms directly. While such waves *can* be propagated with huge antennas

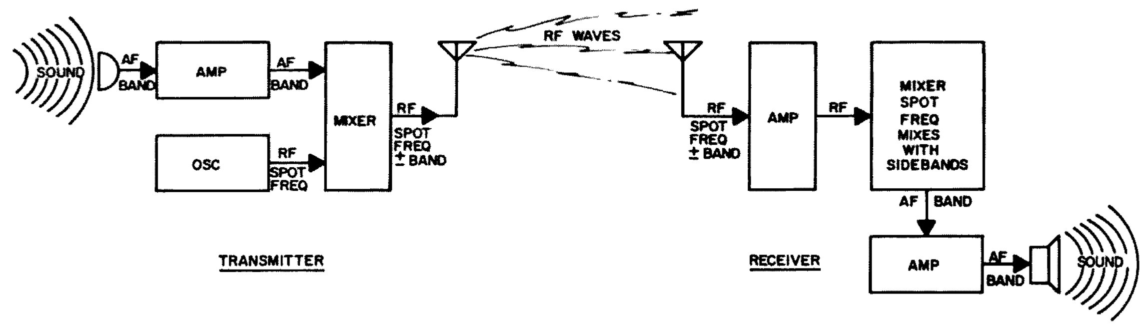


Fig. 1. This simplified diagram shows how sound waves at the transmitter are converted to an audio-frequency band, then mixed with an rf spot frequency for transmission and radiated. At the receiver, the process is reversed, resulting in new sound waves which are essentially duplicates of the originals. Same process applies to all radiotelephone transmission; details of the mixing vary from technique to technique. SSB, for instance, eliminates 75% of the transmitted material but holds all information content.

and megawatts of power, the process is neither efficient nor practical. All phone operation is accomplished by translating the audio band up to the desired spot in the rf spectrum for transmission, and bringing it back down to audio frequencies for the benefit of the receiving operator. This is accomplished by the "mixing" process which is also the heart of a superhet receiver.

What is "mixing"? When two electrical waveforms of different frequency are applied to any circuit which is not completely free of distortion, more than two waveforms come out. Among the "new" waveforms which emerge is one which represents the *sum* of the original frequencies, and another which represents their *difference*. A good mixer will have no other outputs, a poor one, or a circuit in which mixing is only incidental, will have many others, including harmonics of each of the original signals and of each of the outputs, as well as the sum and difference products between each pair of outputs taken separately. If you imagine this as being quite a mess, you are absolutely correct.

If one of the original waveforms was in the rf region and the other was a pure sine wave of audio, the "sum" will be a new radio frequency above the original rf by the frequency of the original audio, and the "difference" will be a second new radio frequency which is below the original rf by the same amount. These are known as "side frequencies" since they are alongside the original rf in the spectrum.

If the audio input to the mixer, however, was a "band" type of signal rather than a sine wave, then the "sum" and "difference" frequencies will also occupy bands alongside the original rf, rather than spot frequency positions. These are "sidebands", and every radiotelephone signal must be involved with them, since they and they alone carry the audio information to the receiver. Even FM has its sidebands, surprising as that may sound.

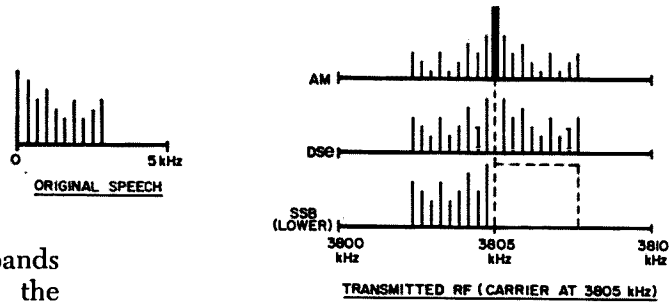
At the receiver, the two sidebands and the original rf "carrier" are applied to a detector circuit, which is simply another type of mixer. The rf sidebands and the rf carrier again undergo a mixing process; the "difference" in this case is a reproduction of the original audio waveform.

Fig. 1 shows the process; it is the same for BCB disc jockeys, military communications, FM, AM, DX, or local work. In every case, the audio put into the transmitter is converted into rf sideband energy, the rf sideband transmitted to the receiver, the received sideband converted back to an audio-frequency waveform, and the waveform finally converted back into sound.

What Is Meant By "Single Sideband" Signals? More than 40 years ago, an ingenious engineer with A.T.&T. noticed that the mathematical expressions which indicated that sidebands existed also showed that the *two* sidebands which accompany every "normal" phone signal were identical in every respect but one—their frequency and phase relationship to the original "carrier" signal—and that this one was a simple mirror-image relationship.

From this, he reasoned that it was a sheer waste of power to generate and transmit both the carrier and one of the sidebands. A single sideband, alone, would convey all the audio. It was an ambitious theory—but when it worked as expected, in 1927, it

Fig. 2. Spectrum views of original audio band and resulting transmitted RF for normal AM (top), DSB, and SSB, assuming carrier frequency of 3805 kc for all three.



proved for the first time that the sidebands actually existed, and also established the single-sideband technique for radiophone communications.

For the first 20 years or so, single sideband was exclusively a commercial technique. Getting rid of the carrier and especially of the unwanted sideband was a tricky operation; more equipment was necessary than most hams could afford in those days. The only reason the original experiment could succeed was the very low transmitting frequency used (below 50 kHz), at which antenna resonance alone provided a sufficiently sharp filter to reject the unwanted sideband and prevent its radiation.

However by 1948 the time was ripe, and O. G. Villard (with others) put W6YT, the Stamford University club station, on the air with SSB. Within a few weeks, the new technique had caught on nationwide. The '50s saw the battle of the sidebands spread across the HF bands, and by the early years of this decade SSB was even a standard operating procedure on VHF and UHF bands.

The characteristic of an SSB signal, tuned in on an ordinary receiver, is a "Donald Duck" or monkey-chatter sound. This results from the total lack of a "carrier" signal against which to mix the sideband. Instead, the sideband mixes with its own strongest components, or with any nearby carrier that happens to lie in the AF region around the sideband itself.

When a locally-supplied "carrier" from the receiver's BFO is provided, however, and the receiver is carefully tuned, there is the original audio. If you don't like the tone of the other guy's voice, you can move the tuning just a trifle and shift his voice an octave or more.

Figs. 2 & 3 shows the spectrum representation of the original audio signal (speech), this same audio translated to rf by normal AM, as a SSB signal (with the missing carrier and sideband dotted), and as recovered in the receiver. Both perfect tuning and mistuning of the receiver are shown in **Fig. 3**, to illustrate how receiver tuning affects the pitch of the received signal.

The important thing to remember about a SSB signal is that it *is* the audio signal itself, translated directly into the rf spectrum. Conventional AM phone, on the other hand, is a "coding" of the audio into rf. The SSB signal cannot be permitted to suffer distor-

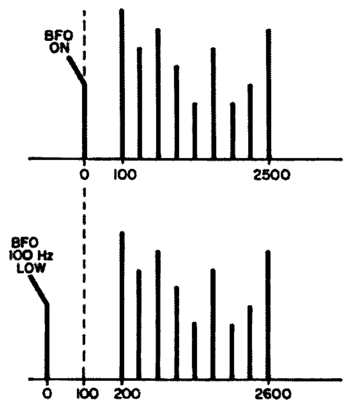


Fig. 3. Effect of receiver mistuning on SSB signal is to shift pitch of all parts of signal. 100-cycle tuning error, bottom, makes all parts of signal 100 cps too high. This is small error for high-frequency portions, but is 100-percent error for lows. Result is almost unintelligible signal. With DSB, result is worse —some of wrong sideband gets into output.

tion at any stage after it is generated, or the individual frequencies within the band will mix with each other to create sum and difference products which were not originally present. These sum and difference products not only cause annoying and illegal interference to other operators (who know it as "buckshot") but can themselves mix with each other to introduce additional distortion back into the original signal.

The single sideband signal must be protected against distortion from the time it is originally generated until it is once again returned to the audio range; this requires not only carefully operated linear amplifiers

in the transmitter, but specially designed detector circuits—product detectors—in the receivers. Development of such circuits is one factor in the rapid rise to prominence of SSB.

In all of this discussion, the emphasis has been on the direct electrical differences which mark a SSB signal. Were these the only differences, hardly anyone would be willing to use SSB. These direct electrical differences, however, produce some startling operational differences which make SSB appear almost 10 times more powerful under difficult operating conditions than ordinary phone at its best.

One of the differences is the fact that since only one sideband is transmitted, only half the spectrum is necessary. This tends to reduce interference between competing signals, and permits use of extremely selective receiving techniques which also combat interference. A second difference also due to the presence of only one sideband is the fact that *all* the legal power is carrying voice; in conventional AM, only half the legal power is carrying voice—and that half is split between two essentially identical signals. In other words, a SSB transmitter can put out around 700 watts of talkpower on the average. While an AM rig can produce only an effective 175 watts or so. All the rest of the power in the AM signal is either furnishing carrier or duplicating this 175 watts of effective voice power.

Probably the greatest advantages offered by SSB, though, is its elimination of the steady carrier signal. This signal, in AM operation, is essentially the same strength as would be produced by the same transmitter operating CW with the key held down. It has approximately 4 times the power of the accompanying voice sidebands. Two AM stations of approximately equal strength, operating 2 to 3 kHz apart, will drown each other out with a beat note equal in frequency to their frequency separation. Two SSB signals of equal strength at the same spacing cause little interference to each other; an operator listening to one will hear the other only as superimposed "monkey chatter" on top of an intelligible signal.

Elimination of the carrier and concentration of all the power into the single sideband offers a few more bonuses, and these are important from a legal (licensing) standpoint as well as for general operation. The exact power of a SSB signal at any instant is determined by the voice waveform which it is carrying, since the signal *is* the voice waveform translated up into rf. Our voices range from no sound at all, during pauses between words, up to rather explosively intense sounds as those which form the words "boy" or "plow". The power level of the SSB signal at its most intense or "peak" value is known as the "peak envelope power".

You cannot read the peak envelope power of an SSB signal from any meter, since the meters respond far too slowly. If you monitor power output of a transmitter with an oscilloscope, you *can* measure peak envelope voltage and from this reading calculate the power.

FCC regulations, however, require that power input to an amateur transmitter be determined by metering the voltage and current applied to all stages which deliver power to the antenna. They recognize that dc meters cannot respond to the variations in level of a SSB signal, which are due to the variations in sound intensity of your voice.

For this reason, the regulations state that the maximum power input as read by meters having a "¼-second time constant" shall never exceed 1000 watts. The key phrase is "¼-second time constant", and that includes almost all high-quality meters. It means that when voltage or current changes, the meter reading will follow it within ¼ second Thus the meter needle never keeps up with the voice peaks, but does record *average* rather than *peak* power.

The ratio of peak envelope power to average power in a SSB signal depends primarily on the characteristics of the operator's own voice, and may range from about 1.2-to 1 up to more than 2-to-1. If your voice is such that the ratio is 2 to 1, then you will be able to produce a legal 2000 watts of peak *input* power while the *average* upon which the regulations are based remains within the limits. If your voice produces a 1.2 to 1 ratio, you can get only 1200 watts peak input while remaining in the legal kilowatt limit.

This is a notable bonus for SSB operation when compared to either CW or AM operation. A CW transmitter is not permitted to run more than 1000 watts input under key-down conditions. This limits its peak input

power to 1000 watts regardless of the average; when sending a string of mostly dits, the average power would be about 500 watts. An AM transmitter is limited to 1000 watts input in the absence of modulation. Addition of 100% modulation brings the peak input up to 1500 watts (1000 watts carrier and 500 watts in the sidebands, contributed by the modulator) but this is still less than the possible 2000 watts with SSB. Especially when you consider that only 250 of the AM rig's 1500 watts are useful and the rest are merely tagging along for the ride.

Despite the possible 4-to-1 advantage in peak power enjoyed by SSB in comparison with CW, the dits and dahs retain the advantage of maximum transmission range. This comes about because CW may be received with only 50 Hz bandwidth in the receiver, while SSB requires a minimum of 2.7 kHz, some 540 times as great. The 4-to-1 power advantage is cancelled out exactly when CW is received with a 675-cps bandwidth. Cutting that bandwidth in half gives CW a 2-to-1 advantage in effective received signal strength, and each additional halving of bandwidth doubles CW's power advantage.

For voice operation, though, no other technique can approach SSB's effectiveness. The nearest competitor is wide-band FM, which requires receivers even more specialized than those for SSB and is also illegal on the HF bands.

How Are SSB Signals Generated? Single sideband signals may be generated in any of three ways. The two most common methods are by filtering out the unwanted sideband, and by phasing out of unwanted components. The other method, known only as "the third method", combines parts of both the filter and phasing techniques, and is so critical in operation that it is almost never used.

Regardless of the method used, the starting point is always an rf signal which is modulated by the audio which is to be transmitted. Normally, the carrier is eliminated during the modulation process by use of a "balanced modulator". This is a circuit which accepts as its inputs an rf signal and an audio signal, one of which is applied in push-pull and the other of which is applied in parallel, and from which output is taken in push-pull. The resulting phase reversals of the rf signal as it mixes with the audio signal cancel out the constant-phase carrier component and leave only the two sidebands

In the "phasing" method, not one but two balanced modulators are employed. The rf signal is phase-shifted by 90 degrees between the oscillator and one of the balanced modulators, and is applied to the other modulator without any phase shifting. Similarly, the audio signal is shifted in phase by 90 degrees before its application to one of the modulators, and is applied to the other with no phase modification. Phase relationships in the modulator circuits make one pair of sidebands (either both lowers or both uppers) identical in phase at the outputs, while the other (unwanted) pair is 180 degrees out from each other. The unwanted signals then beat each other's energy out, while the desired sideband components assist each other on through the transmitter. Either pair can be selected by reversing connection of the two audio paths to the two balanced modulators. **Fig. 4** shows a block diagram of this "phasing" technique.

In the "filter" method, the rf signal is applied to only one balanced modulator. The resulting double-sideband-less-carrier signal is passed through an extremely sharp filter which passes only one of the two sidebands.

In the "phasing" technique, the original rf signal can be at any frequency from the low *if* region up to VHF, and the only part of the generator which requires adjustment (besides, of course, the various tuned circuits) is the rf phase-shift network. In the "filter" technique, though, the original rf signal must

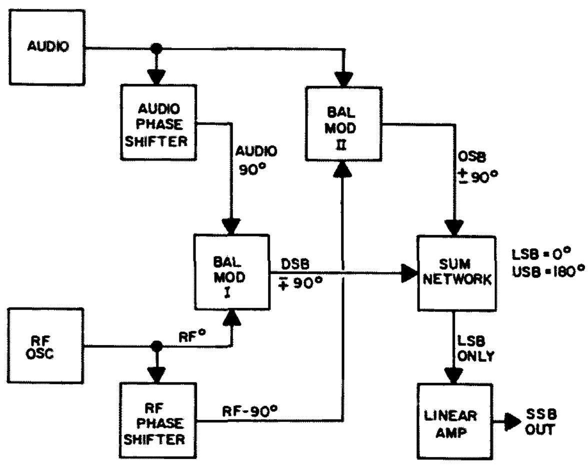


Fig. 4. Block diagram of phasing method of generating SSB signal. With phase relationships as shown, lower sideband signal is generated; to get upper sideband, move either (but not both) phase-shift network to feed opposite modulator. Success depends upon careful adjustment of all controls; up to 40 db suppression can be obtained but 30 db is more usual figure in practice.

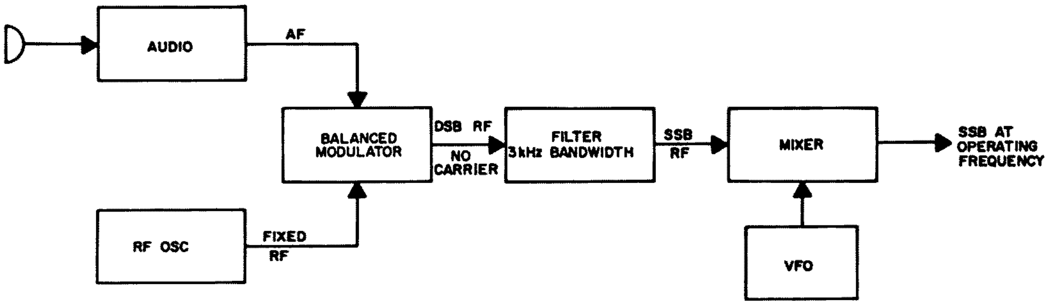


Fig. 5. Block diagram of filter method of generating SSB signal. Either upper or lower sideband can be generated by modifying frequency of RF oscillator to properly position DSB signal at filter input, with regard to filter's passband. Filter's rejection helps eliminate carrier and makes adjustment simplier than with phasing method, but careful operation is still necessary.

be at such a frequency that the desired sideband matches the passband of the filter rather precisely. Early filter techniques could not achieve the required selectivity at frequencies very much above the audio range—one of the first popular SSB filters operated at 17 kHz! Mechanical filters raised the frequency up to the normal *if* region around 455 kHz, and development of crystal lattice networks has since raised the filter frequency as high as 9 MHz. Regardless of the frequency, it is fixed for any one generator by the filter frequency. In practice, phasing units are usually also adjusted at fixed frequency.

Since the signal is at a fixed frequency when the carrier and unwanted sideband are shaved off, some means of moving it to the desired operating spot must be provided in any practical generator. This normally consists of a stable VFO and a mixer which is very like a receiver's product detector. Output of the mixer is then amplified as much as desired (or to the legal limit) by linear amplifiers. Fig. 5 shows a block diagram of a typical filter-method SSB generator including the VFO and mixer stages.

The VFO and mixer operate to transform the SSB signal to some other part of the rf spectrum in just the same way as a normal modulator or a receiver's mixer move audio up to rf or vice versa. The mixer in a SSB generator is operated with particular care so that no distortion products are introduced, but the output always contains both original input frequencies, their sum, and their difference. The "sum" frequency has the same characteristics as the original SSB signal, but the "difference" frequency is inverted and becomes the "opposite" sideband. One of the favorite frequencies for generation of a SSB signal in the early days, and one which is still widely used, is 9.0 MHz. This permits a sum output in the 20-meter band, and a difference output on 75 meters, from the same 5-Mc VFO. The inversion caused by using the difference frequency is the reason old-timers on SSB considered LSB standard on 75, and USB standard on 20. Anything lower than 9 MHz required LSB, and anything above USB. With improvements in operating and construction techniques in the past few years, you can now find either sideband in use on either band.

How Is SSB Transmitted? Transmission of a SSB signal neither begins nor ends with generation of the signal itself. Before being applied to the SSB generator, the audio is normally shaped for maximum effectiveness. Broadcast quality is *not* the objective; communications punch *is*. To meet this end, the bandwidth of the signal is usually limited to the effective 300-3000 Hz range. Often, some measure of volume compression is applied—although this will change the peak-to-average power ratio, by trimming the peaks back and boosting the normally weak parts of the syllables.

For the phasing method, frequency limiting is necessary; the phase-shift networks operate well only within this range. In the filter technique, the limiting will be done by the filter anyway. Despite this, the audio is normally shaped at an earlier stage in order to concentrate power where it will be used. Many operators begin the frequency-shaping at the microphone by using a mike which responds primarily to the speech range and tends to reject other frequencies.

The processed audio signal goes into the SSB generator, regardless of the sideband-generation scheme employed, and a SSB signal at final operating frequency comes out. This signal is, however, rather puny; about the most produced by typical SSB generators

is around one watt. To compete with the big boys, amplification is necessary.

And since distortion of any type is taboo with SSB, the rf amplifier used must be of the "linear" variety. Now "linear" is a word with almost as many different meanings as it has users. The most general meaning is "distortion-free". Any type of rf amplifier *can* be operated in a manner which makes it "linear" in this sense, but some types are easier to linearize than others.

For instance, to make a class C amplifier—typical of AM and CW final stages—operate as a linear, considerable special circuitry and careful adjustment is necessary. The net effect is a sort of cross between an amplifier and a modulator, but it can be made to do a good job if you have enough patience. The technique has been described in detail elsewhere; the idea here is to look at all the linear amplifier techniques but none in extreme detail.

A properly adjusted class B amplifier—an amplifier which is operated exactly at the cutoff voltage—will reproduce the envelope and frequency content of a SSB signal without distortion, and so it too is linear.

The class A amplifier—one in which plate current is never cut off during the operating cycle—is easiest of all to make linear. If grid bias is adjusted so that plate current remains constant through the syllable cycle, and if drive to it is kept within bounds, it's difficult to make one of these distort. Unfortunately, only about 20 to 25 percent of the dc power comes out as rf, so they're not the most efficient approach to the problem.

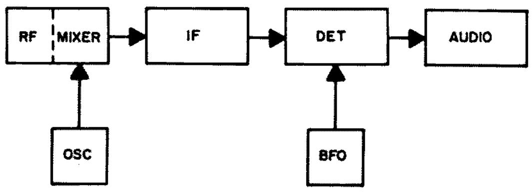
Most transmitter designers settle for the class AB_1 approach. This is an amplifier adjusted to operate midway between class A conditions and those for class B; no grid current flows, and plate current rarely is reduced to cutoff (never in a properly operating design), but plate current *does* vary through the cycle. With no signal input, most amplifiers of this type are adjusted to dissipate the maximum power possible within the tube ratings. As signal is applied, plate current rises—but dissipation decreases. Eventually, with continually increased input, the point is reached at which additional input results only in distortion rather than in increased output. Normally, though, grid current is drawn just before this point is reached.

The fact that most class AB_1 amplifiers are still distortion-free when grid current sets in can be used to advantage in the "automatic load control" circuit which has gained wide popularity. In the speech-processing portion of the transmitter, a compressor circuit is included. The control signal for this compressor is taken by rectifying and amplifying the "hash" which appears in the final grid circuit as the grid draws current. Thus when grid current appears, a control signal is applied to the compressor to reduce the input signal level. This negative feedback prevents distortion by automatically reducing drive whenever the input signal level is excessive. Of course, like all "automatic" devices, it can be overloaded—but used with some intelligence, it is a powerful aid.

The main factor which prevents distortion when the SSB signal is amplified in the transmitter, however, is the proper tuning and adjustment of the amplifier stage. All adjustments must be on the nose for proper performance; sloppiness which would never be noticed with most AM or CW rigs results in a SSB signal which fills the band with "buckshot" and can rapidly earn you a pink ticket for spurious radiation.

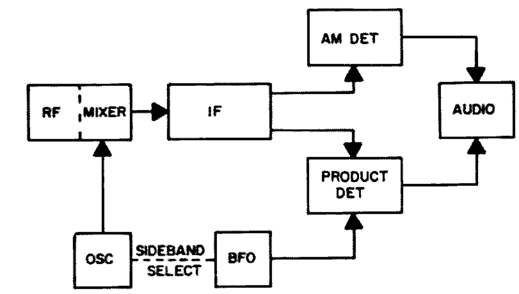
Grid bias must be at the proper level. Too much will result in intermodulation (third-order) distortion, and too little will restrict the amplifier's ability to handle high-level signals. Drive must also be proper. Too little hurts only your output power; too much results in flat-topping and consequent splattering over the spectrum. Coupling to the load (either next stage or antenna) must be correct, so that the load reflects the proper impedance back to the amplifier plate. *All* of these adjustments interact strongly with each other. As a result, the only way to be sure of proper operation is to tune up with an oscilloscope.

To tune up with a scope, connect the scope to the transmitter output (through a coupling link, not direct) and apply a two-tone test signal to the input. With a phasing rig, all you need do is insert carrier. With a filter rig it is often easier to apply two sine waves of different frequency to the mike jack. The scope should display a perfect bow-tie pattern if operation is correct. Too much bias makes the diagonals of the bow-tie concave. Too little bias, or too much drive, flattens the peaks. Too little loading makes the diagonals concave. For additional details on interpreting the pattern, refer to any of the SSB handbooks. The important point to remember at this stage is that SSB signals may be ampli-



(A)

Fig. 6. Block diagrams of (A) a communications receiver for AM/CW use only and (B) a selectable-sideband receiver for AM/SSB/CW use.



(B)

fied without distortion only by a properly designed *and* properly operated "linear" amplifier. Either poor design or poor operation will introduce distortion, and consequent illegal operation.

How Is SSB Received? Once transmitted, the SSB signal must be received. While almost any receiver can be used (it's a matter of record that one-tube regenerative "bloopers" have successfully copied SSB), most operators consider a reasonably good superhet with sharp selectivity, a slow tuning rate, and exceptionally stable oscillators the minimum for serious SSB use.

Importance of stability is directly due to the small margin of error for reinsertion of the suppressed carrier; a mistake of as little as 20 Hz—that's the same tolerance broadcast-band commercial stations must keep—is clearly audible. Much more scrambles the voice beyond recognition. The slow tuning rate is important for the same reason; a jeweler's delicate touch can substitute for this, though.

The selectivity is necessary in order to take advantage of the capability present in the SSB signal. If the receiver's acceptance band can be trimmed down to just the width of the one sideband in which you're interested, then all possibly interfering signals near the sideband but not actually in it will be reduced or eliminated. Such a receiver is known as a "selectable sideband" receiver since it can select either sideband of a normal AM signal.

A selectable sideband receiver can receive any type of signal which can fit within its 3-kHz passband; it is not limited to just single sideband signals. The selectable sideband receiver can receive CW, SSB, DSB (double sideband suppressed carrier), or AM signals interchangeably. It *may* be able to receive narrow-band FM or PM signals as well, although as a rule special detector circuits are necessary for these "angle-modulated" (FM or PM) signals.

Whether SSB, DSM, or AM signals are being received on such a receiver, the technique is similar. The receiver's BFO is adjusted to a point just outside one edge of the passband, and the receiver is then carefully tuned until the signal becomes intelligible. If an AM signal is being received, the receiver is tuned for zero-beat (or the BFO may be turned off). This effectively shaves the unwanted sideband from a DSB signal, turning it into an SSB signal at the receiver instead of at the transmitter.

CW signals are tuned in by the same method except that the BFO may be adjusted to some other point on the passband, depending upon your own personal preference in beat-note pitch. Some operators like relatively high notes, around 1 kHz, while others prefer low pitches, from 50 to 200 Hz.

A good AGC system is also essential in a receiver for SSB use, since the signal varies at such a rapid rate. Normal AVC won't work right; it cuts in and out far too rapidly, producing a "thump" each time it cuts in and permitting noise to roar up between syllables of a word. For sideband use, a "fast-attack" "slow-release" system is necessary; this one acts rapidly when signal strength increases, but holds gain down for some time after the signal goes down (as long as 1 second in many cases). This permits the receiver gain to match the *average* rather than the *peak* levels of the SSB signal.

Selectivity, stability, slow tuning, and good AGC are all essential to SSB reception. Yet all of these are wasted for long-session use unless the actual detector circuit of the receiver is properly designed. Today's receivers almost invariably include "product detectors" for SSB use; the older breed, which is still with us in large numbers, did not.

The product detector is simply a name for

a type of low-distortion mixing circuit which accepts two radio frequencies (normally the *if* and the BFO) and produces only the sum and difference outputs, without adding intermodulation distortion or other forms of garbage to the audio output.

By contrast, the older diode or peak envelope detectors produced distortion levels as high as 15% of the audio signal itself. This difference didn't have much effect during short listening sessions—but during contest operation, for instance, it made the difference between keeping the top of your head in place and blowing it clean off your scalp!

To sum up reception requirements for SSB, Figure 6 shows block diagrams of (A) a communications receiver for AM/CW use only and (B) a selectable-sideband receiver for AM/SSB/CW use· Note that the sideband receiver contains all the required functions for the other two types of reception, and merely adds a few new ones.

Next: One of the most important areas of any license exam deals with transmitter design and adjustment techniques. Next time we'll get into the first of three looks at this key subject. Don't go away . . . ■

Technical Aid Group

If you have a question which can be answered adequately through the mail, look through the following list of TAG members and write to one whose specialty covers your problem area. Be sure to explain your problem clearly and write legibly. Enclose a Self Addressed Stamped Envelope for a reply. Do not ask a member to design a piece of equipment for you. The purpose of this group is to assist the ham with problems he encounters in the course of building or trouble shooting.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on *any* subject.

Jim Ashe W2DXH, R.D. 1, Freeville, New York. Test equipment, general.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Theodore Cohen W9VZL/3, BS, MS, PhD, 261 Congressional Lane, Apartment 407, Rockville, Maryland 20852. Amateur TV, both conventional and slow-scan.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic

keyers, digital electronics, IC's, commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters, receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM, FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Howard Krawetz WA6WUI, BS, 654 Barnsley Way, Sunnyvale, California 94087. HF antennas, AM general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434–7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Wintzer DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4, Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

David D. Felt WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors, SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB–HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Helmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America. Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

CORRECTION

In the VHF Remote Control article (April, page 32) please change the 35 second timer in Figure 7 to a 3.5 second timer. Also, on the voltage control relay, connect points two and three with a jumper. This is fairly, but not completely obvious from the diagram.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

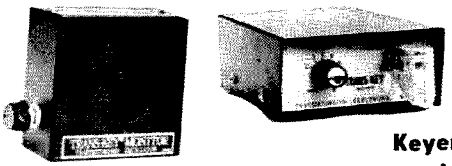
William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland, Oregon 92705. This group of radio amateurs will answer any technical questions in the field of electronics.

GLOBAL IMPORT COMPANY

TRANSKEY(TM)
Still Going Strong



Keyer and Monitor

$29.95*

Has been sold around the world to commercial ship operators and amateurs. The new Trans-Key (TM) is a new development for ham radio by licensed hams. A highly sensitive relay driven by a blocking oscillator offering variable speeds from a few words to 50 wpm, is but one interesting feature. This eliminates worries about voltage polarity or potential. The keyer and accompanying monitor are both penlight cell powered or an external 6 volt source can be used. The key contacts are adjustable. A single switch on the back changes operation from automatic (self completing dots and dashes) to semi-automatic or "bug" operation (non-self completing). No rewiring required as on some keyers. Not a kit! Ready to operate as code practice unit or with rig! Variable tone control. Dimensions of keyer: 3⅝ x 5⅝ x 1¾". Keyer set weighs 2 lbs. Dot-space ratio adjustable.

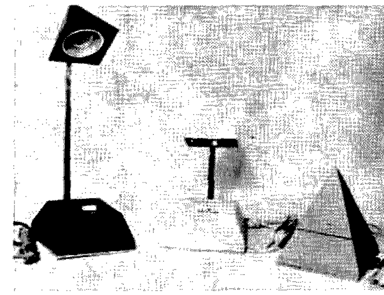
MONITOR separately available for code practice. Uses one penlight battery. Has tone control. **$5.95***

MYSTERY JET WATCH

ONLY $9.95!*

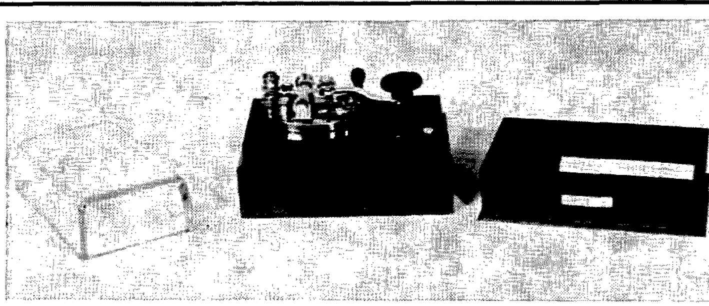
Mystery jet second hand appears to be suspended in space. Calendar watch gives date also. Water resistant, anti-magnetic. A real conversation item. Buy them by the dozen cheaper and sell or give them away! Your amateur radio call letters put on dial for additional $1. One year guarantee.

PYRAMID LAMP! LIGHT UP THE HAM TABLE



6" high pyramid. Telescopic arm extends 15". Turn it on-off, hi or low. Uses standard GE bulb. No need to heat the whole room. Focus light where you want it. Choose your color —Bright red, white, blue, beige or green. Wt. about 2 lbs!

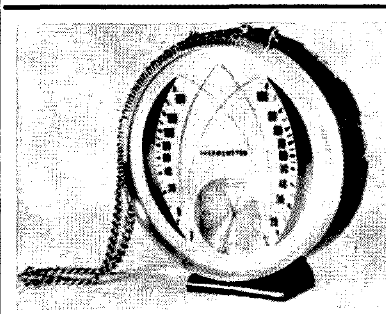
ONLY $9.95!*



HAND KEY & GAS LIGHTER!

All handcrafted with base of Italian black or white marble and a box of walnut. When ordering please specify color base desired. The key can be used for code practice with a high pitch buzzer or a gas light. The key and its base sit on a cigarette box and is fitted with a glass cover which doubles as an ash tray. This beautiful hand made treasure comes from Japan.

$24.95*



RADIO-THERMOMETER CLOCK-HUMIDITY

$17.95*

Novelty combination—suspend on wall with gold colored chain, on stand or table. Round maroon plastic cabinet with brass colored front rim. In one unit you get an alarm clock, a thermometer, a humidity indicator and a six transistor radio. Uses a standard 9 v battery.

MONEY BACK GUARANTEE: Return any item in good condition with ten days after receipt for full refund.

*Please include $1 for each item to help cover postage and packing. California residents add 5% sales tax.

NOTE: The Trans-Key is unconditionally guaranteed one year. Nominal service charge after that. All keyers are serial numbered. Distributors wanted on all items.

Write to W6PHA, GLOBAL IMPORT CO.

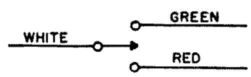
Box 246 El Toro CA 92630

Robert A. Mauro WB2UHY
150-30 18 Ave.
Whitestone, N.Y. 11357

Frequency Spotting the "Sixer"

Here is a crystal frequency spot for use with the Heathkit "Sixer" (HW-29A), using two wires and a SPDT switch. Easy? You bet!

1. Remove the wire between lug 2 of L1 and lug 2 of L2.
2. Solder one end of an 8″ piece of white, insulated wire to lug 2 of L1.
3. Solder one 8″ length of red colored insulated wire to lug 2 of L2.
4. Connect a third wire (green) to lug 3 of TR switch.
5. Mount S1 (SPDT) on front panel directly below the words "The Sixer."
6. Feed all three wires through grommet U.
7. Connect wires to switch (S1) as shown in **Fig. 1.**



Before attempting modification, be sure your rig was engineered after October 9, 1964, or modification might not work.

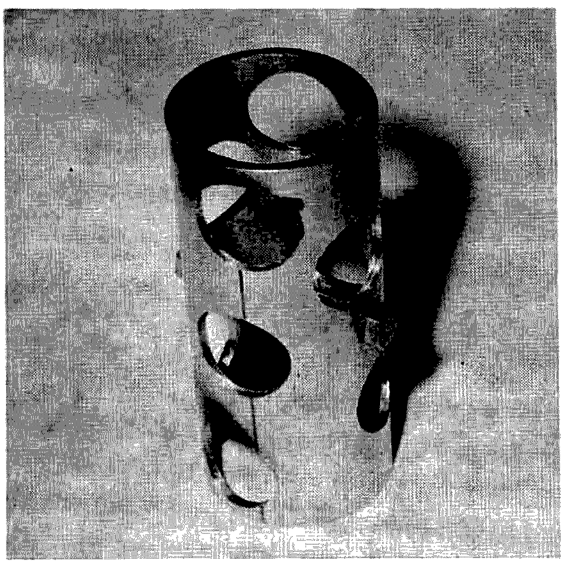
. . . WB2UHY

SOME NOTES ON OUR

REGINAIR 321 QUAD

Perhaps you too looked at the familiar "H" pattern of the conventional 3 band quad and wondered how acceptable performance could be had from such a configuration. To Larry Johnson, WA1BUN, this concept was all wrong for the electrical spacing between elements varied widely and obviously the resulting terminal impedance of the driven elements varied equally. Trying to connect one feed line to three different impedances is touchy and mechanically difficult. The outcome, it was reasoned, was a constant electrical spacing for all three bands. This was achieved in the Reginair Quad by means of a spider type design, the hub for which is illustrated here. Eight inches long, 3½ inches in diameter, and a thick ¼ inch wall give ample mechanical support to the four aluminum tubes, which in turn support the insulating dowels. This aluminum hub is drilled to accommodate up to 1¾ inch diameter masting, to which the hub is fastened with a ½ inch plated steel bolt.

Constant electrical spacing resulted in a terminal impedance on each band of 100 ohms. This is transformed down to 52 ohms by a Q section of RG11/U cut for 21 megacycles (when matching 2 to 1, a Q section works very well over the octave from 14 to 28).



The bugaboo of suck-out, caused by 10 meter radiation from the 20 meter element, has consistently plagued Quad builders, for VSWR invariably jumped on 20 meters—the very band where we wanted the flattest response. After many trials, Mr. Johnson resolved this problem by inserting a quarter wave 10 meter shorted decoupling stub made of RG8/U, within the 20 meter driven loop.

No baluns need be used with the Reginair 321 Quad. The Quad is a full wave device, not a half wave. As a result, the RF currents from both the sheath and the center conductor of the feed balance out and no balun or balancing device is needed. You can prove this with 2 RF ammeters. In other words, the Reginair Quad is self-balancing; it is, in effect, its own balun.

Previous quad design used stubs or other devices to achieve low VSWR. Our Quad needs no adjustments of any kind—no loading coils—and yet reflects less than 1.5 to 1 VSWR over the entire 10, 15, and 20 meter bands. This most important feature is obtained by making the reflector loops very slightly larger, tuned to a slightly lower frequency.

The measured gain of this Quad is 5.9 db, compared to a conventional dipole; 8.5 db as compared to an isotropic dipole. The front to back will be 25 db equivalent to an average of 4 S units on a typical receiver.

This Quad is quickly assembled from a complete package with pre-assembled driven and reflector elements. All you need do is furnish the 52 ohm feed and raise it into position. A light TV rotator, such as the AR22R ($33.95) will swing it easily. The completed Quad weighs but 35 pounds and requires 19 feet of area, or 9½ feet of radius.

The most salient feature of our Quad is its flat response. This is particularly important because most hams today use transceivers or transmitters that can accommodate only VSWR of up to 2.5 to 1 at the most. Consider your finals and the longevity of their life, and you can see why. In a typical illustration, a pair of 6HF5's are employed as finals in a transceiver with a 400 to 500 watt PEP rating. The tubes themselves are TV horizontal oscillator types, with a dissipation rating of 30 watts each. Sixty watts then is the most you can tolerate. The idling current of the finals is 50 mills times 800 volts or 40 watts. At 2.5 to 1 ten per cent of the forward power is coming back to roost. With 250 forward watts from our transceiver, 25 watts are returned. Twenty-five and forty equal 65 watts—5 more than should be considered safe. As you slide up and down in frequency, think of what is happening in your rig—unless you had the good judgment to operate at your antenna's resonant frequency, or better yet, the wisdom to use our Reginair Quad where the VSWR is guaranteed to be less than 1.5 to 1.

Remember too, a quad has more than twice the capture area of a similar rated beam. In the case of the 321, more than 350 feet of wire are used.

To you doubting Thomases, read what WØKHI had to say. "I want to add my name to the many satisfied users of your new Quad. This is the first Quad kit that I have purchased that was a 'true' kit and not simply a do it yourself bunch of quad parts to homebrew. All the parts used in your kit are of good quality and well put together; the wire used is especially appreciated for ease in Quad assembly. It does give me for the first time an SWR that pleases me; it is between 1.2/1 and 1.0/1 on all bands."

The Reginair 321 Quad is available at $89.95 in one improved model using poly vinyl chloride tubing of two dimensions and an indestructable ABS spider hub. The shipping weight is 37 lbs. packed in a cylindrical tube 6' long by 6" in diameter and therefore suitable for inexpensive Parcel Post APO mailing. Delivery from stock.

HERBERT W. GORDON COMPANY

Woodchuck Hill Road • Harvard, Massachusetts 01451

"Helping Hams to Help Themselves"

The 321

George Johnson WA1BUN
43 Raymond Street
Nashua, N.H.

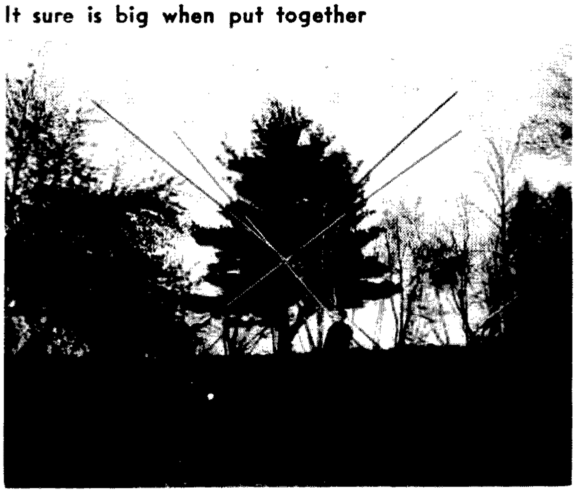
A New Quad Design

3 bands, 2 elements, 1 feed line

In 1965 I moved to the city of Nashua, New Hampshire, into a house which had no antenna facilities whatsoever. Having had considerable experience with beams in the past, and knowing their limitations, I decided this time that I would put up a Quad. The quad had a reputation as being a fine antenna, and yet there was a considerable amount of discussion on the air with respect to the relative merits of a quad versus a beam. I decided that I would find out, even if it meant doing it the hard way and experimenting all the way through. First, I found out that there weren't any finely drawn lines on quad design. When I talked to most fellows about quads, everyone seemed to agree that although the quad was a fine antenna, they would invariably end up by describing theirs from a mechanical point of view. For example, "I got it up, and boy, I had a hard time tuning that thing up; but once I managed to tune it, why, it seemed to work fine." Then other fellows would tell me about what happened to their quad when the first storm came and took it away.

After some study of the construction methods employed by conventional quad design I began to understand why so many people had trouble with their quads. In a conventional quad design, which essentially was shaped like the letter H, having a boom of 8 to 10 feet and cross spreaders on each end, the quad loops themselves are strung across the spreaders, with the whole structure being supported by a slim mast and a light rotator. I began to understand why such a quad would wave with the breeze, slop up and down and not maintain any fixed electrical configuration.

It sure is big when put together



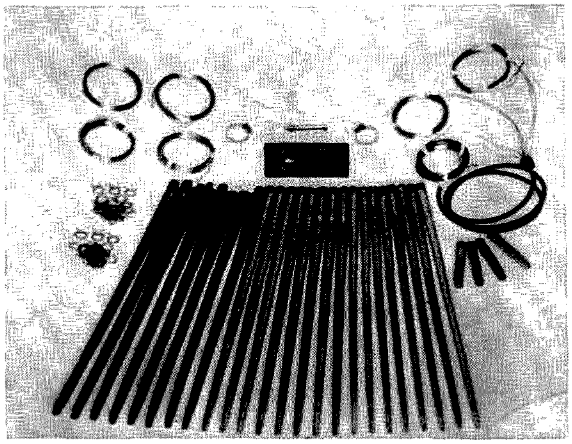
I wanted my quad to stay up, and I wanted to have a different design. And still in all, I wanted my quad to operate on each of the 3 high frequency bands most popularly used in amateur radio, the 10, 15, and 20 meter bands. I recognized that the physical distance between the 10 meter sections, 15 meter sections, and 20 meter sections were one and the same. But since the electrical distances were different, this would have to result in an odd ball combination of impedances, which would be difficult to match. This became more and more apparent as I went to look at the problem of feeding. The 3 different electrical spacings in a conventional system yield 3 different feed impedances. The prospect of matching elements to a single feed line, which was my goal, seemed very remote. So, looking around, it became evident that some drastic revision in my overall concept of a quad had to be realized. At about this time, in various publications, I found evidence of a boomless type of quad, or spider design, which had spreaders radiating from the center in a V type of configuration. Obviously, the different driven elements and reflectors would provide a different set of spacings on a frame of this type, and evidently the boomless hub would be a good

starting point for me. I also realized that if someone were to put 4 cross-brace wires between the corners of the loops, it would pull this type of quad into a more rigid, boxlike structure, which could put real tension on the loops and prevent any spreaders from bending individually.

Before I started construction of my first quad, I decided that I had to build a crank-up tower. This was constructed out of 2" x 4" and 1" x 6" lumber, actuated by a hand crank winch. It consisted of a cross-braced A frame with a T section upper member, pivoted in the middle. The whole thing was mounted on my back porch, in such a position that it could be cranked up or down with the aid of the winch, thus lowering the top of the antenna down into a double turn-around in my back yard, for easy work. This seemed to be necessary if I was going to develop any kind of an antenna, for I realized that I would have to crank the tower up and down innumerable times. This proved to be a modest prophecy, for ultimately I had to crank the tower up and down at least many hundreds of times before I was satisfied with the resulting quad.

My first attempt at building a quad was to use all aluminum construction. I found that using aluminum resulted in serious capacitive loading effects on the elements in the quad, to such an extent that their resonant frequencies were considerably lower, and that unless the aluminum spreaders were severely broken up with insulating material, the radiation pattern was adversely affected. What I'm trying to say is that the spreaders themselves, made of aluminum, would absorb rf energy from the resonant elements, and distort the radiation pattern of the quad severely. I didn't get anywhere with it, so I turned instead to insulating materials for the spreaders.

My first attempt, for insulation, was to use wood for the spreaders. Many quads use bamboo. Fiber glass was, of course, available, but it seemed to me that a good solid piece of wood, particularly hard wood, if it were treated properly to prevent weathering, would last a long time and could be used. Then, too, I decided to make the center portion of my quad out of aluminum tubing, heavy thick wall tubing. After all, why not take advantage of the strength of aluminum tubing at the base of the quad, where it does not have to carry any electrical elements and where all of the mechanical stresses stem, or come from. An aluminum spider hub, illustrated here, was my first attempt to work out this thing mechanically. Even this was a long time in evolving. I had to plan just how the shape of the holes could be drilled so as to fit the design of the spider quad and still at the same time preserve mechanical strength sufficient to take care of the job. I made the spreaders, or dowels, out of a combination of aluminum and wood. They were, overall, 13½ feet. This type of structure seemed reasonably good mechanically, and I therefore started experimenting with various configurations of wires, attempting almost any length to try to make a quad for 10, 15, and 20 meters, on the one frame. The first attempts used conventional stub tuning. I just tied all of the elements together at the feed point, figuring that problems would develop, and I surely wasn't wrong. The 20 meter section would radiate when I fed 10 meter energy into the 10 meter section. The VSWR's were humped, and very, very poor. More experimentation showed that we were getting pretty close to a consistent 2 to 1 mismatch on each of the 3 bands. That is to say, the best match available was about 2 to 1. I analyzed the resulting feed impedance from such a configuration, and I found that the quad was consistently higher than the 50 ohms which I had planned to use. Since the mismatch was the same on all bands, it would seem to prove that at least I had the right idea in choosing the spider type of design. I needed to find some corrective device to broadband the resulting quad. The study of the various publications revealed that a Q-match is a good means for attempting such a transformation of impedances. And, of course, a Q-match is a relatively



This is the complete 321 kit

The junior op figured out the more complicated assembly

broad band device. So this was tried, and we found that by cutting the Q match section for any one of the 3 different bands, we would obtain a perfect match for that band. We also found that if the Q match section were made out of RG11 cable, which has a 72 ohm impedance, and we designed this for 15 meters, that the match was very good for both 10 and 20 as well as 15 meters.

My next specific goal was to try to obtain the best front to back ratio, or forward gain, for my quad. I realized that this meant that I had to tune it up very accurately. I found to my surprise that tuning the quad was indeed very difficult. My first attempt at tuning the quad was made with a grid dip meter in the regular, accustomed fashion. I found that the reflector elements had to be approximately 200 kilocycles lower than the low limit of the amateur band involved, in order to have a reasonably decent VSWR. Stub tuning was trickier than I had assumed. Furthermore, the tuning would move, and sometimes rather unpredictably, when I raised and lowered the antenna. So, it was not always easy to tune the antenna in a down position and have the same results when it was put up in an operating position. I did, however, make the quad this way, and was able to get reasonably good results with it, using just plain conventional stub tuning. The results of this type of tuning meant, however, upon close examination, that the front to back ratio varied across the band. It didn't seem to matter how closely the reflector was tuned to the low end of the band, the front to back ratio would seem to deteriorate at the high end of that band. I reasoned that the stub was an inductive loading center for the reflector. It was probably raising its Q and lowering its band width and thereby narrowing the range of frequencies over which it could operate effectively. Accordingly, I determined that I would try to design the reflector without any stubs at all. The reflectors were altered and I found that we actually had to make the poles or spreaders longer, to accommodate a full-sized 20 meter loop, instead of that which he had been using before. Now the 20 meter loop was a full 72 feet around. I wanted, in effect, to have a long enough reflector and full size dimension so that it would resonate at approximately 13.8 megacycles on 20 meters. In this concept, which was subsequently proven correct, the results were outstandingly different in our favor. In the first place, all we did was to make a calculated length cut, and put the loop on what was supposed to be a theoretically correct length. We ran the quad up into operating position, and somehow it worked. Furthermore, the front to back ratios across the band were now consistent. That is to say, they were generally between 20 to 25 dB, whereas in the tuned stub version, we had as much as 7 dB of deterioration at the high frequency end.

The next problem to be encountered was that of suck-out energy on the 20 meter loop, when the system was fed with 10 meter energy. The 20 meter element represents 4 half-waves on 10 meters, and it will absorb energy in the feed line on 10 meters, unless something is done to kill the resonance, or somehow make it a poor impedance match on the 10 meters.

My first thought was to try a parallel tuned trap tuned to 10 meters and inserted in the 20 meter driven element. Sure, this worked after a fashion, but to make an impervious seal against the weather, and still have it remain tuned to its original frequency was most difficult. This trap had to have appreciable inductance in order to reach the Q necessary to effectively trap out 10 meters. This meant in turn that a considerable portion of the remaining 20 meter driven loop was being wasted and not being used to radiate properly and further reduced the desired band width. Not only that, but the idea of losing energy in such a trap was against my better judgment. There had to be a better way, and there was. I finally employed a piece of 50 ohm coax, 5½ feet long, connected with its open end at a point half wave up from the feed point in the 20 meter loop. This move was the proper one, as proven

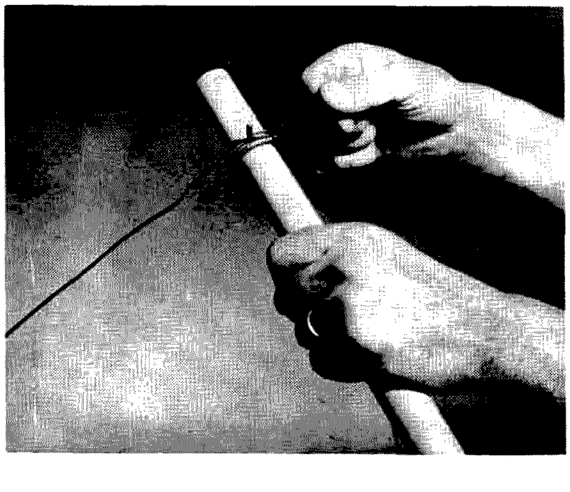
from a simple test of feeding 10 meter energy to the 20 meter loop and then going around with a neon bulb to detect voltage points on this loop. Better instrumentation revealed that the 20 meter loop no longer served as a 10 meter antenna.

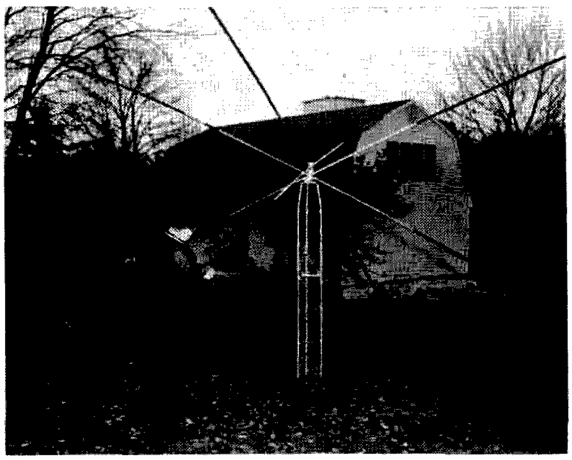
At this point in terms of time and progress I had a fine performing antenna—but in line with trying to improve still more, felt a need for installing a coaxial balun as a series element from my main feed line, a broad band device with lumped constants. First, I knew that it would be necessary to establish existing standards on the performance of the quad as it now was. Accordingly I plotted frontal lobes and observed that the radiation was beautifully symmetrical. Reports confirmed this study. Perhaps I didn't need a balun. So I measured the rf with a small ionized gas stick around the square of the driven loop. Deionization occurred at the same equidistant points from center feed. Two rf current meters inserted at the junction or feed point both read the same current, proving again the fact that the full wave loop was in itself a balun, and therefore needed no external device to effect radiation balance!

What pleases me the most after a year and a half of experimentation is the unmistakable fact that the resulting quad has singular merit in that it affords me the lowest and flattest VSWR over the entire 3 bands (10, 15, and 20) of any antenna I have ever used, including most commercial beams and dipoles. The freedom from worry concerning high VSWR means that I can operate CW at the bottom of 20, then merely swish up to the top of the sidebanders without disturbing the load on the rig. My finals are really protected with this antenna! The front to back is a consistent 25 dB; the greater capture area of the full wave antenna plus its unusual vertical and horizontal configuration enables me to hear stations earlier in any day and then again later in the day at the closing of the MUF which are not otherwise identifiable on a competitive 3 element beam pointed similarly and used concurrently. Even though this Quad design is inherently limited to a gain over a dipole of about 5.9 dB, some other parameters must be working for me, for the reports indicate marked superiority whenever a test is suggested. Again, my belief that the quad could be mechanically improved has been borne out in practice. Evidently other hams feel this way too, for I have been kept busy making reproductions of this original "Queen of the Air" ever since. Moreover, there are no traps, baluns, stubs, or adjustments of any kind necessary to the final Quad. It's simply a case of assembling precut wire loops and precut aluminum and wood spreaders before you, too, have a similar Quad.

The 321 quad is being distributed by the Herbert W. Gordon Co., Harvard, MA 01451.

Attachinq the wire to the spider ends





Almost finished and ready to raise

"Yipes! I thought this was my soldering gun!"

Letters

Dear 73,

Anent your comments in current 73 (Feb), I can but whole heartedly agree: there is absolutely no respect for any sort of law and order on the ham bands, and it is getting worse. Our major problem, right now, is one of *enforcement*. Same problem on the 11 meter band. I too have heard the mish-mash on W1AW's signal, the horror that 75 has become, and the awful messes on 15 and 20. There are "broadcasters" and clowns with motor-driven "aroooga" horns, belches, and assorted obscenities. These are pale when compared to the drunks on the air.

I feel strongly that we have come too far along the road we have taken to ever clean house—not without a greatly strengthened enforcement division in the FCC and a quadrupled budget for them. The State of the Art has indeed advanced, but our society seemingly has regressed. The common attitude seems to be "the hell with it", and that's it.

F. C. Hervey W9IIU
Chilton, Wisconsin

Dear 73,

How clever of you to put your "April Fool" article in your February issue!! I'm referring to the hillarious article by W4PJG, "How to Get Better Returns from your QSL". I worked W4PJG on Grand Cayman Island as ZF1EP and sent three QSLs with SASE each time but received nothing in return. I suppose the answer is in the advertisement contained in his article, "A small contribution anywhere from a dime to a dollar is appropriate"—he already has 16c of my postage.

I can suggest another DXpedition he might undertake!

Luther D. Miller, Jr. WA3FMO
Washington, D.C.

Dear 73,

Banzai and tally ho to your Feb. Editorial Liberties. Amen to the fact that amateur radio is in a sorry mess by and large. Agreed that a general house cleaning is in order and long overdue. Like you, I find myself restricting encouragement to prospective amateurs and the number of tests given. We should consider the overall value to the Service in dealing with those who aspire to join us.

It appears the only way to clean up the bands is for each of us to do some serious soul searching, abandon our inconsiderate and hoggish attitudes, have more regard for the other fellow and if necessary, place some restrictions on our band habits and attitudes. If each of us individually attends to this problem of bettering amateur radio as a whole—then we got it made, friend. Bless that small percentage who are a credit to the Amateur Radio Service.

G. L. Baker W8GIU/5
Dalhart, Texas

I like to think it is the SMALL percentage who are NOT a credit to the ARS.

Dear 73,

The article on Operations Deep Freeze by Ralph Steinberg moved me to the point of writing this letter to you. I did thrill to the article very much as I felt to be a small part of it.

I might say that I enjoy 73 very much and part 1 of Getting Your Higher Class License was very interesting. I know of no better ham magazine at the present time.

Edward Kovalan K8AVO
Clarksburg, West Virginia

Dear 73,

So at long last the great secret is out—we now know the dead truth—the Editor of our favorite magazine really *is* a woman! Here in Europe the argument has raged fast and furious over the local natter bands as to the sex of *73's* new Editor. It was generally agreed that Kayla sounded as if it should be a woman's name, but then most *73* readers were equally sure that absolutely no feminine hand could possibly write technical articles! So, the consensus of opinion was that W1EMV must definitely be a man. And now we know . . . what a letdown for so many radio amateurs who are sure the XYL could not even be trusted to dust the shack.

Donglaa Byrne G3KPO
Peterborough, England

Gulp! I'm glad you can't see the dust in my shack. . . along with bits of wire, globs of solder, and parts scattered all over the place.

Dear 73,

In the February 1968 73, W4YM asks why he gets greater difference in comparing a 2 element vs a 4 element quad on transmit than on receive. The answer probably lies in the fact that his SWR on receive is significantly higher than on transmit. I would guess the quads were tuned up using his transmitter so that the antennas were matched to his transmitter feed line. However, the SWR is determined by the impedance of the *load* and when receiving this is the impedance of the receiver input.

Line losses will also affect SWR and if there are additional transmission line losses (such as for a T/R switch) for the receiver as compared to the transmitter this will also increase the receiver SWR and impair its performance capability.

Forrest Wilcox W2CT
Yorktown Heights, N.Y.

Dear 73,

Through the medium of your magazine I would like to thank all those amateurs who handled our radio telephone patch traffic from Korea over the Christmas Holidays. There were several and one in particular I would like to thank is W7CHZ, who was so faithful in coming up on frequency daily and handled 90% of our traffic. There were many tears of joy on this side of the ocean when these patches were completed. The Commanding General 2nd Inf. Div. sent out certificates of appreciation to those who handled all patches and believe me, fellows, our hats are off to you.

Indianhead Amateur Radio Club HL9TF
APO San Francisco 96224

Dear 73,

On incentive licensing: I am buckling down, studying for that Extra and find the work and discovery is recapturing some of the thrill and fun of amateur radio. I was quite skeptical, but I think it will be a feather in amateur radio's cap for the future.

On bad operating practices: I am staggered, apalled, and aghast at things I have recently heard on 40 SSB. The saddest was malicious CW QRM of a SSB QSO consisting of pure anglo Saxon 4 letter words. I'm no prude, but conduct of this sort can be the downfall of amateur radio. Why can't these guys realize that?

The "Getting Your Higher Class License" series is a superb idea and will be a positive contribution to amateur's self improvement. Bravo for publishing an excellent magazine that is not afraid to face problems extant in ham radio today.

Dong Hutchinson KØDTK
Lompoc, California

Dear 73,

The new license program may turn out to be our salvation. Already, one can sense a lessening of the immediate feeling of resentment which followed it's inception. The human race thrives on competition and that is really all that incentive licensing means.

Robin Gaardsmoe K3UUL

Dear 73:

It is with great interest that I read your editorial in the April issue of 73 on the subject of UFO's.

Having been for several years an active investigator on behalf of NICAP in this area as well as being an active ham, you can see why your article would be interesting to me. I have kept up with this subject for about ten years and have read about everything available, both pro and con, on these objects.

I could relate many interesting experiences I have had investigating these reports, however, since that would take too much space, I can only state that having made these investigations and studying the story in depth, I have become thoroughly convinced on the reality of the objects.

A good friend, Jim Rogers, WA4UHK and myself have discussed a possible UFO net on several occasions. We came to the conclusion that it would work only if we had the backing of one of the Amateur Radio publications to get it started. You have of course taken care of that problem.

Both Jim and myself would like to throw our names in the pot to help if the net becomes a reality. Neither of us have KW rigs which would probably be needed for net control stations but will assist in any other way we can.

D. H. Robertson WA4KLT
Greenville, S. C.

CRAZY-MAN-CRAZY

250 KC I.F. amplifier — Removed from COLLINS airborne, 618S-1, transceiver, for technical change order. Has (2) 5726/6AL5, (3) 5749/6BA6 tubes; (2) IF cans; (1) F-250 A-67 mechanical filter; AVC & audio detector circuits. All enclosed in module 3" wide, 4½" deep, 3½" high, + 1¾" for tubes, IF cans, etc. (5 LBS). With schematic and description .... **$30.00 ea.**

CO-AX SPOT T-R relay — For latest MOTOROLA Mo-Tracs. 75 ohm, 12v DC coil. Handle 100 watts RF thru 500 Mc. ALLIED #RBX-21 or MAGNECRAFT #120-X2. Has SO-239 on short UG58A/U; phono tip on 20" RG58A/U & phono-tip on 7" shielded lead. BRAND NEW (2 LBS). MOTOROLA DEALERS—replacing this item, write for quantity price. 6 for $20.00 .... **$3.50 ea.**

HAMMARLUND #MC100SX — 12 to 100 pf, 2000v variable capacitor. 35 plate (18 rotor, 17 stator) 4" long, 1¾" wide, 1½" high, +1½" for dual ¼" shaft; 2 ceramic end plates; 2 bearings; BRAND NEW. 2 LBS). 4 for $5.75....... **$1.50 ea.**

MILLEN #21140 — 140 pf, 600v variable. 35 plate, (18 rotor, 17 stator); 1¾" long + 1½" for dual, threaded ¼" shafts; 2 1⅝ x 1⅛" ceramic end plates; 2 bearing, silver plated. BRAND NEW (1 lb). 4/$3.75 .... **$1.00 ea.**

SHAFT COUPLERS ¼" to ¼"

National #TX-9, 1¾" diameter ceramic wafer; 2 insulated metal couplings, with set screws. BRAND NEW. 4 for $1.50 .... **39e ea.**

Nylon rod, ½" diameter, 1¼" long, ¼" hole, each end ½" deep. Middle thinned to ¼" diameter, for flexibility. BRAND NEW. 5/$1.00 .. **23e ea.**

Western New York, Convention, Hamfest and what have you. **(Even Wayne Green has promised to be there)**, Rochester, N.Y., May 11, 1968. Broezeshooters, White Swan Park, Pittsburgh, Pa., May 19.

All orders, except in emergency, or I'm at a hamfest, shipped same day received. For free "GOODIE" sheet, send self-addressed, stamped envelope—PLEASE, PLEASE include sufficient for postage, any excess returned with order. I carry private (Travelers) parcel post insurance, for domestic parcel post. For items too heavy, or too large for parcel post, I suggest bus parcel express. Please advise name of bus line, and city, where you can pick up the shipment. Canadian customers—PLEASE add sufficient for postage—$1.00 first two pounds. 30c each additional pound or fraction.

B C Electronics

Telephone 312 CAlumet 5-2235
2333 S. Michigan Avenue Chicago, Illinois 60616

OA1046/GPA23 Control Console w/one 12", one 5" & four 3" electrostatic Scopes. For 110V60cy power. ....EX 125.00
Load Bank 150A 31.25V 11 80A SPDT Switches. NEW 27.50
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T465/ALT7 200W Xmittr 168-352mc w/two 6161's. EX 18.75
6161 Tube w/Connectors. 100 watts to 1200mc .....EX 6.75
TCS Xmittr/Recvr Control Box with Speaker ......EX 7.75
R443/ARN5D 332-3mc Recvr w/11 Tubes, 6 Xtals ..EX 6.50
R101A/ARN6 100-1750kc Rcvr. Needs 28VDC only. EX 27.50
ID91B/ARN6 Navigators Bearing Indicator ....EX 7.50
AS313B/ARN6 Station Seeking Loop. 100-1750 kc. ..EX 6.25
RT316/APN12 160-234mc Transceiver w/Tubes ....EX 12.50
ID169C/APN12 Scope. 3PP1 CRT. DPDT Coax Switch LN 9.75
AM300 Interfone Amp. w/4 Tubes & Dynamotor ...EX 4.75
PP336 Main Power Supply for APR9 Receiver ....EX 16.50
PP337/APR9 Klystron Supply for TN130, TN131 ..EX 10.50
ID226/APR9 Panoramic Indicator w/Schematic ....EX 14.50
SN7C/APQ13 Synchronizer w/24 Octal Tubes ......LN 9.75
J39/APQ13 Junction Box. 102 Screw Terminals ....NEW 2.25
Same but w/50 feet 4-cond. shielded cable ......NEW 6.25
R316A/ARR26 14-Tube 162-174mc AM/FM Superhet ..22.75
PP468 Power Supply for R316A Receiver. 400cy. ..LN 4.75
C610 Control Box w/4 Tubes for R316A Recvr. ....EX 4.50
Cable Connects PL259 to BNC Panel Socket ....LN 3/1.75
Vaneaxial Fan 18-28VDC/AC (60cy) 60 cu ft min. EX 3.25
OHMITE Z-50 Radio Frequency Choke ....EX 6/1.00
Seone Xformer 1950V@3ma.5 Fil Windings. 60cy. NEW 4.75
SA325/U Coaxial Switch. SP4T. 28VDC Motor ....EX 6.50
3JP1 CRT w/Mount. Shield. Socket & HV Cap ....LN 4.75
Rt. Angle Drive w/Gears, Universal, ¼" Shafts ....EX 1.35
TS250A/APN1 Test Set w/Cables & Attenuator ..EX 22.50
Capacitor, Feed-thru. 15 on Panel. Three Panels 1.00
BNC (UG290/U) Coaxial Panel Sockets ....EX 6/1.00
Coax 6" long w/BNC (UG260A/U) Plug each end. EX 4/1.00
Coax 8" w/1 BNC Plug & 1 BNC Panel Socket ..EX 3/1.00

E. C. HAYDEN **Box 294, Bay Saint Louis, Mississippi, 39520.**
Prices: FOB Bay Saint Louis. Terms: Net, Cash.

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★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

THE KNIGHT RAIDERS VHF Club will hold its Second Annual Hamfest on Saturday, July 20, 1968 at Weasel Drift Picnic Grove, Garret Mt. Reservation, West Patterson, N.J. from 10 am until dark. The location is the same as last year. Manufacturers displays, swap shop, junque tables, contests, door prizes, and a good time for all will be the order of the day. Picnic tables and barbeque pits available. No tickets, no fee, it's free. Refreshments will be available. Talk in station K2DEL/2 will operate on 50.4 MC and 146.898 MC. Special certificate for contacting the talk in station available. For more details write K2DEL.

THE AMATEUR RADIO ASSOCIATION of Bremerton, Inc., Bremerton, Washington, will hold its annual Hamfest on May 18, 1968 at the Westside Improvement Club. Tickets are $4 per reservation or $4.50 at the door and $2.00 for each child. Registration begins at 1 pm with various activities during the afternoon and dinner at 6 pm, following by drawing of door prizes. Dancing will conclude the day's festivities. Reservations and further information may be obtained by contacting either the ticket chairman, Doug White, WN7GXL, Box 12, Belfair, Wash. or Harry Hill, W7CQI, ARAB President, 3230 Harren, Bremerton.

HEATH HA-20 Linear $79.00. Surplus BC-611 Handi-Talki $25.00. SX-42 Receiver, needs work, $45.00. New 813 Tubes $10.00@. Ampex one inch video tape, 5,000 foot reel $10.00. You pay postage. Bruce Hilderbrand, 6090 Upland Terrace South, Seattle, Washington, 98118.

ST. PETBRSBURC AMATEUR RADIO CLUB, INC. will hold their annual Hamfest at Lake Maggiore Park, entrance gate at 9th Street and 38th Avenue South, St. Petersburg, Sunday, May 19. Plenty of parking space. No charge for entering Park. All Hams and guests cordially invited. This is an old fashioned Hamfest, picnic lunch, swap table, and prizes.

TEST EQUIPMENT, etc. Large variety, including H.P. 400B; Simpson 260 $30, 269 $45, 38 $30; Beckman counter #7370 10cps-10mc $650; Tetronix scope plug-ins $30 to $125; BC 659 Transc. $10. Send 25¢ for large list of test equipment, etc. Palen Electronics, P.O. Box 1536, San Mateo, Calif. 94401. Phone 341-9747.

IMMACULATE SR 160 w/dc supply and cables. $175.00. Will ship. K7HVE, 103A University Village, Salt Lake City, Utah, 84108.

HX-20 XMTR. 80-10M SSB and CW. Professionally wired by Collins Radio Engineer. Excellent condx. $110. James Demler, WØDSU, 1100 W. Godfrey Ave., Apt. 407, Philadelphia, Pa. 19141.

GALAXY V MODIFICATION KITS: Foot-Switch CW Operation, external receiver antenna jack, three extra relay connacts, and more. $15.00 pp. Write WB6NWW, 5349 Abbeyfield St., Long Beach, Calif. 90815.

DAH-DITTER ELECTRONIC KEYER . . . New integrated circuit automatic keyer. Fully self competing on both dit and dah. Built in AC supply and keying monitor. Isolated reed relay output. Completely assembled and ready for operation. Price $34.95. Order now direct from: M&M Electronics, Keyer Dept., 6835 Sunnybrook, NE, Atlanta, Ga. 30328.

WRL's USED GEAR HAS trial—terms—guarantee! 75A1—$169.95; G66B—$39.95; 913A VHF Amp.—$179.95; Apache—$99.95; HA10 Amp—$189.95; HW30/2'er—$44.50; AF67—$49.95; Ranger 2—$149.95; 2B receiver—$179.95; Valiant—$149.95; HQ100—$99.95. Low price on hundreds more. Free "bluebook" list. WRL, Box 919, Council Bluffs, Iowa 51501.

516E—1 D.C. POWER SUPPLY 351D2 Mount for Collins KWM-2 both $135.00. Excellent condition. M. Halle, 1520 Turcot Dorval, P. Que., Canada. 514-631-6676.

SPRING AUCTION of the Rockaway Amateur Radio Club will be held Friday evening, April 26, 1968 at the American Irish Hall, Beach Channel Drive at Beach 81st St., Rockaway Beach, N.Y. Come to the best Auction in the New York area. For detailed directions write to the Rockaway ARC, PO Box 205, Rockaway Park, N.Y. 11694.

FOR SALE: Lampkin 105 Frequency Meter $140, 205 Modulation Meter $140, Model 15 Teletype 60 words excellent $40, W8CJP, 11446 Lakeshore, Grand Haven, Michigan, 49417.

FOR SALE: Heath Apache TX-1 very clean, $90; also like new Hammarlund HQ170C $165. K1MWF L. J. Burns, RFD, Plainville, Conn. 06062.

ATV OR CLOSED CIRCUIT CAMERA, new, self contained power supply, video output, & 3-6 transmitter $265.00. W2MCA Rivoli TV, 287 W. Merrick Rd., Valley Stream, N.Y. 11580. 516 LO 1-8090.

LOS ANGELES AREA—Complete station—Heath SB-301 with all filters and Johnson Ranger with PTT, mike, key, manuals—like new, $350. Phone 213-323-3823.

CERTIFICATE will be issued by Henry Ford Museum to any station that works the Motor City Radio Club station, W8MRM, during the 24 hours prior to the Old Timers Night banquet. Work W8MRM on May 4 (GMT) on or near 3.663, 3.900, 7.070, 14.300, 50.178, 145.350, or 146.94 Mc. QSL for certificate. Peter Tippett, WA8VIF, Sec'y., Motor City Radio Club, Greenfield Village, Dearborn, Mich. (novice contacts by schedule.)

FOR SALE: Steward Warner 390A/VRR Recv. $850.00; RBA 15kc to 600kc recv. $45.00; National HFS rcvr. 27mc to 230mc $60.00; Heath Imp Bridge IB-1 $40.00; 50 watt 6 meter AM XTMR H.B. $35.00; model 15 teletype complete $70.00. W2ØAP J. Murray, 40-33 61 St., Woodside, N.Y. 11377.

HEATH APACHE transmitter for sale for $130. In excellent condition. Will ship. WA4ZGQ Rodney Bland, 512 Roberts St., Ahoskie, N.C. 27910.

BROADCAST TV I.O. camera, camera chain, std. R.M.A. sync generator, w/interlace, D.A.'s, tripod, lenses and many various associated TV equip., reg. supplies, etc. $1,500. W. Kayler, 205 Lonsdale Rd., Prospect Heights, Ill. 60070. 312-259-8791. S.A.S.E. for list.

PM RB—AF 68—AC-DC SUPPLY $150. Clegg 66ER $140. New Heath capacitor checker $20. You pay shipping. WB4HNT. 3799 MacLamar, Montgomery, Ala. 36111.

LAB TUNED RTTY-88MH TOROIDS. $2.50 ea. p.p. 1275, 2125, 2295, 2975 Hz. Ask for other freq. R. Jeffrey, W6ØXK, 639 Outlook Ave., Oakland, Calif. 94605.

KLEINSCHMIDT TT76A (typing reperf, keyboard, TD, & Table) Brand new with manual & spare parts $100; 2 KW bandswitching linear amplifier using a pair of 4-400 A's with CCS power supply $350 or trade for Drake R-4. Will deliver within 100 miles. Warren WA3JYI, 2828 S. Simpson St. Philadelphia, Pa.

WANTED: For private collection, radio gear, parts, catalogues, spark gear, tubes made before 1927. Especially DeForest, Federal, Grebe, Kennedy, early Atwater Kent, Paragon, Marconi. G. Angle, Clear Lake, S. Dak. 57226.

FRESNO HAMFEST, May 3-4-5th at the Tropicana Motel, 4061 N. Blackstone, Fresno. Tickets $8 until April 27th, include registration, prizes, banquet, etc. Send to Box 783, Fresno, Cal. 93721.

APR4 COMPLETE with 3 tuning units, 2-38 Mc to 95 Mc. 1—74—320 Mc. A steal for $75. K. R. Hancock, P.O. Box 299, Endicott, N.Y. 13760.

SB-300; SSB, AM, CW filters plus 2M converter; excellent, $200 or best offer. SASE for other Heath equipment. Edward F. Jurow, 20314 Harding, Olympia Fields, Ill. 60461.

EXCELLENT CLEGG 66'er, $175. RME 4350, $75. Must sell for college expenses. Larry Jennings WAØPLE, Box 176, Basehor, Kansas 66007.

SHACK CLEAN OUT SALE: Incrm. Osc. Chassis, units inclue 10Xtals from 10 to 11Mhz., tube, toroid step relay, plug. trimmer, etc., $40 Value, only $3 ea. Eimac, RCA, Ampex tubes: 833, 6155, 7378, 5867, 304TL, 4X500, 3X3000, SK300, $14 each gntd. 6166, 3CX10,000, 4-1000, $49 each RCA Dual Xtal Ovens $1, 3/$2, 6M or 10 M FM Xmter—$14. SW54 Rcvr.—$25, Mohawk RX1 Rcvr.—$99, TX86 Xmter—$59, Walkie-Talkies—$4 ea., TN3B, TN1B Convert—$14 each 6 & 2 M. convert—$9, Sola 2% P/S. 200-300V, 250 ma—$9. $5 for Surprise Box of Miss. Pieces. WA8GFR, 1423 West 52, Cleveland, Ohio 44102.

DAYTON HAMVENTION April 27, 1968—Wampler Arena Center, Dayton, Ohio, sponsored by Dayton Amateur Radio Association. QSO in person at the nation's foremost radio event of the year. Technical sessions, exhibits, hidden transmitter hunt. Bring the XYL for an outstanding Ladies Program. Join the satisfied participants who return year after year in celebrating Ohio Amateur Radio Week. Watch the Ham ads for information or write Dayton Hamvention, Box 44, Dayton, Ohio, 45401.

FOR SALE: National NC-300, and 2 meter converter, $150. Barker & Williamson B&W5100B with Heath SB-10 side-band adapter, $110. David Ruth, 256 The Uplands, Berkeley, Calif. 94705.

MINT GALAXY III SSB Transceiver, Galaxy 12 VDC Mobile Supply, Turner Mobile MIC, Instruction Manual. $295.00. K6UAW Mal Oakes, 356 Yacon, Vista, Calif. Phone 714-724-7584.

REPLACE TUBES in Health VTVMs with FETs and Silicon diodes. Performance including Temperature stability maintained, portability added. All components with complete instructions $10.00. Send schematic for quote on other VTVMs. Circuits Maximums, 906 Carnegie Avenue, Plainfield, New Jersey, 07060.

SEE MY AD on page 123 of 73 Magazine for January—will trade for stereo tape deck, recorder, 35 mm photo enlarger or camera, or what have you? KIABE—Rumford, R.I. 02916.

JOB WANTED. French F9WK wants electronics job in States. Age 35, 18 years electronics experience, excellent English. W4BXD will sponsor. Address A/C Falmet Bernard, E.R.V. 04-94, 18 Avord-Air, France, or W4BXD, James W. Hudgins, 1213 East Clinton Avenue, Huntsville, Ala. 35801.

PRINTED CIRCUIT KITS, etching powder, 3 circuit boards, resist, circles and tapes, $3.50 PPUSA48, Calif. add tax. William Deane, 8831 Sovereign Rd., San Diego, Cal. 92123.

BLANK PRINTED circuit boards 092-032 thickness copper both sides, 4" x 8". 5 boards $1.50 plus postage. Bill Hayward, 3408 Monterey. St. Joseph, Missouri 64507.

TRADE SWAN 350 in good working order for Swan 250 in same condition. J. P. Delaney, 1452 Calle Madreselva, Thousand Oaks, Calif. 91360. Telephone 805-495-5546.

HQ-110 $100; DX-100 $45; 0-11 scope $30. All with manuals and in gud condx. WB6PBI, 612 Miller Ave., Pacifica, Calif. 94044.

WANTED IN GOOD CONDITION: Complete set Codex Tapes; Ham M Rotator; Millen Grid Dipper; VHF Gear. Hal Lami K4GGV, RR5, Box 334, Mobile, Ala. 36608.

REWARD for information leading to procurement on manual on Yuba-Dalmotor mobile linear and power supply. Roy Brougher, W4IK, 3743 Wesley Drive, Montgomery, Ala. 36111.

SBE-33 TRANCEIVER with DC supply and mount, perfect, $200. HR-10 receiver, excellent, $55. DX-20 Transmitter excellent, $25. David Ruscitti WA1FRC, 63 Grant St., Milford, Mass. 01757.

RETIRED—Moving QTH—Must clean out. Meters—oil condensers—amplifiers—modultator—dynamotors—transformers—tubes, etc. Sase, 5 p. list. Trites. W1JJ. 165 Parkway, Melrose, Mass. 02176.

FOR SALE: 420 Sams PF, covering Nos. 1-620—$250.00; 13 volumes Rider TV manuals—$150.00; N.R.I. Radio-TV course, 6 volumes W/VTVM & chassis—$75.00. All FOB. WB2YYX Robert Wendel, 160-20 Grand Central Pkwy., Jamaica, N.Y. 11432.

KNIGHT T-150A XMTR $75; R-1000A rcvr, all extras, $75; Mike, xtals, SWR, FS meters, Coax Antenna Switch, $25; Mint. Steve, 107 William, Sikeston, Mo. 63801.

HT-44 WITH PS-150-120, $240; Drake 2B with crystal calibrator, $190; selling both in excellent condition. Also selling SB-33, $140, works well with Heathkit MP-10, $18. FOB Railex Lompoc; WA6PGA, RFD A97; you can phone me at 805-736-3762 for $1 for less at night rates.

WANTED: TRANSMATCH—Mullen or Johnson—What have you. State price wanted and condition. Ollie Eggen, WAØILY, Crane Lake, Minn. 55725.

MECHANICAL ELECTRONIC DEVICES CATALOG 10¢ . . . Teletype Model 14 reperforator with automatic tape take up rewinder 115VAC60cy. Both units new, unused $69.95 . . . ARR27 Receiver 29 tubes 465-518 MHz w/60 MHz if new, unused $35 . . . 1/16 laminated copper clad 2 oz. 2 sides, for printed circuits 9½ x 4½ $1 . . . 3/$2. Transistor boards bananza $5.95 . . . Wide band balanced modulator $4.95 . . . 30 MHz IF Assembly $5.95 . . . Transmitter TDG w/Modulator easily converted to 2 meters $49.95 . . . Low pass filter 0-32 MHz 52 ohm $9.95 . . . 5KV/2KV/1KV at 750 ma/200ma/250ma Power supply. Write for details. Fertik's, 5249 "D", Phila., Pa. 19120.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

WANTED: Military, commercial, surplus, Airborne, ground, transmitters, receivers, testsets, accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

DUMMY LOAD 50 ohms, flat 80 through 2 meters, coax connector, power to 1 kw. Kit, $7.95, wired $11.95. pp Ham KITS, Box 175, Cranford, N.J.

HAM RADIO CONVENTION: The Lockheed Amateur Radio Club (W6LS) will hold a Ham Radio Convention May 18th and 19th at 2814 Empire Avenue, Burbank. The displays, demonstrations, and talks will be of interest to all hams, as well as to those who plan to become hams. In addition to displays of the latest equipment and accessories, top speakers will provide excellent programs both days and prize drawings will be held throughout the 2-day event. Full particulars are available to those who request it in writing or who call 848-9340. This club regularly conducts free amateur radio licensing courses which are open to everyone who wants to become a ham.

THE ASTRO Amateur Radio Club Swapfest Sunday May 19, Humphreys Park, Linton, Indiana. Free Lunch. No Charge. Information: Jr. Barnard WA9RUU, Route 2, Linton, Indiana 47441.

LOUISVILLE HAM KENVENTION, Saturday, August 31 at the Executive Inn, featuring Dealers and Manufacturers; Technical Forums; Prizes; Contests; Fashions for the Ladies. 648 South Fourth Street 40202.

73

JUNE 1968

60¢

AMATEUR RADIO

SURPLUS

73 MAGAZINE

June 1968
Vol. XLVII No. 6

Departments

Wayne Green W2NSD/1
Publisher

Kayla Bloom W1EMV
Editor

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $12.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A. Entire contents copyright 1968 by 73, Inc. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458. Say, don't read all this fine print. Get on to the articles, or better yet, send for our new DX Handbook.

de W2NSD

This UFO Network idea has led me into some interesting circumstances.

While trying to get Noel Nelson W3SSB to run another ad for Uncle George's Hamshack, I mentioned my net scheme and his ears perked up. Seems he has a friend who has been following the UFO news for some twenty years or so now. Sure enough, a bit later the phone rang and a Harold Salkin was calling from Washington, D.C. to find out what I was planning. I think we talked for an hour, for he was a mine of information. He gave me leads on getting UFO photos and fan bulletins.

A few weeks later Harold called again to say that he was down near Boston with a "contactee." He invited Lin and me to come down the next day and talk with Woody Derenberger, who claims to have talked with the UFO people and gone with them for a visit to their home planet. Woody was in town with Harold to give a lecture the next night and a radio interview.

Well, I couldn't pass up heady stuff like this.

We drove down and talked with Woody for a couple of hours and found his story fascinating. I'm afraid that Harold was disappointed that I came away still a skeptic. Woody most certainly was not an obvious fraud and I have to admit that there is a chance that he may be telling the truth. Perhaps we shall see, for he told me that the UFO people had recently bought some transceivers and that I could expect to be in direct contact with them within a month on our ham bands.

He explained that since their telepathic ability was so well developed they had never needed radio as a communications or entertainment medium. However, since they are now anxious to contact us without creating panic, they will be using radio. Woody felt that the radio amateurs might be the first large group contacted.

I wonder what prefixes they will use? Just about everything has been allocated by the ITU except, I believe, the calls starting with Ø, 1 and 2. Miller has kind of used up the 1's, so perhaps our friends from Lanulos (that's the name of the planet they come from over in Alpha Centuri . . . the trip only takes a few minutes by space warp drive) will use the Ø calls. I do hope they check with the ITU before starting though . . . we don't want another upset over the use of illegal call signs.

They might use the call letter prefix of the area they are flying over as part of the call. Like ØW1NSD might be my call if I were fortunate enough to get a ride in a UFO equipped with a ham rig . . . or should I use ØW2NSD/1? Why not use a simpler call, as long as I'm making it up anyway, such as ØW1A? And if they decide to subscribe to 73 . . . which I assume they would do . . . what address should we use?

Say, it you work some of these fellows before I do, you'll let me know about it, won't you?

The E.I.A.

The manufacturers of amateur radio equipment are now organized as a section of the Electronic Industries Association. I may be putting the matter bluntly, but I don't think I am exaggerating if I say that this organization was born out of frustration with the League over the Incentive Licensing proposals. This is a large and powerful force and may well have a good deal to say about the future of amateur radio.

In its first move, the EIA has petitioned the FCC with regard to the Novices to:

1. Reduce the code speed requirement to the minimum consistent with the Geneva Convention of the ITU. Since the ITU regulations specify no code speed this would mean merely the recognition of the Morse characters and the ability to send them.
2. Restore phone in the 145-147 MHz band.
3. Set up a phone/CW band for Novices on 29.4–29.6 MHz.
4. Make the Novice license a five year renewable license.
5. Permit the Novice license to be issued to previous holders of licenses.

It will be interesting to see what the ARRL reaction is to these proposals and if they are published in QST.

The problem of code speed is one that

Turn to page 114

Jack Grimes, W4LLR
Box 16004
Memphis, Tenn. 38116

Transformer Tricks

An Air Force Mars Member had just been issued an SP600. I happened to walk in as he finished connecting an 8-ohm speaker to the 600 ohm output.

"I won't be able to use it this week end," he said ruefully, listening to the faint distorted sound. "I won't be able to get in a supply house till Monday to buy a 600 to 8 ohm transformer."

"Where's your junk box?" I asked.

"Nothing in there," he protested. But he dragged out a carton of odds and ends.

I selected a small potted power transformer from the mess. Quickly we soldered wires from the 110v winding and connected them to the SP600. Then another pair from the 6.3 winding to the voice coil of the speaker, leaving the H.V. winding unused.

Again he fired up the receiver. Sound blared.

"Well, I'll be darned," he exclaimed. "How did you know that would work?"

He was genuinely amazed, yet he had held a ham ticket over ten years.

The incident recalled to my mind another instance when a fellow ham had been scrounging for a modulation transformer. I handed him a 220v primary, 350-0-350 v secondary, surplus power transformer.

"Put the rf B-plus through the 220v winding and the modulator plates to the 350v taps," I told him.

"But that's a power transformer," he objected, "won't there be a mismatch."

"Probably," I had agreed. "And I'm sure the slide-rule boys will give you a dozen reasons why. But I've built a half dozen rigs with power transformers for modulation."

A week later I listened to my friend's six meter rig in an on-the-air test. The audio quality was as good as any on the band as far as my ear could tell.

Bob turned the audio on the SP600 back to a respectable level and my mind returned to the current situation.

"Nothing to it," I finally got around to answering him. "I use the same deal at home, between my 600 and my RATT converter. And speaking of different uses for transformers, the input transformer of the converter is an output transformer turned around. In fact, I'd say offhand that there has never been a transformer manufactured which couldn't be used for a half dozen other applications beside the one it was specifically designed for. Sooner or later a ham who likes to build can find a use for just about any transformer."

Bob grinned. "Even the 400 cycle variety?"

"What's the voice range in cps?" I asked.

He got the point.

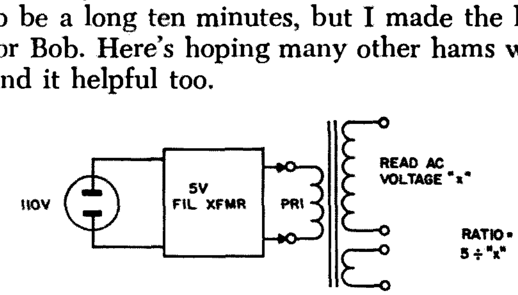
"Actually," I went on, "just a little common sense will get you a long way with transformers, and I don't mean to be giving a lecture on transformer theory. You can find that in the handbook. But you probably know that generally the voltage depends on the turns ratio. The current on the size of wire and core. Also the impedance and resistance will be low with few turns and heavy wire, and high with many turns of small wire.

"So the trick when you need a transformer for any application is to determine the ratio, impedance and resistance range acceptable, and look for this.

"Why I bet I could make a list of a dozen and a half transformer tricks and substitutions in ten minutes—which can save a lot of dough."

"I wish you would," Bob said.

So my neck was stuck out. It turned out to be a long ten minutes, but I made the list for Bob. Here's hoping many other hams will find it helpful too.

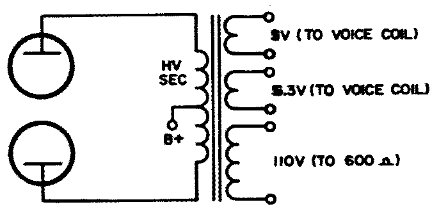


Simple Test Set up for ratio and voltage

1. Test set up

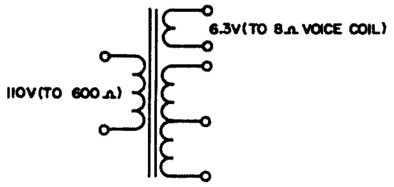
With an unmarked power transformer, proper identification of the windings may usually be made with an ohmmeter. The low resistance being filament, high resis-

tance the high voltage, and the one in the medium-low range being the primary. To determine the ratio, and voltages under use, the test set up below is recommended. Apply 5 volts (Or other convenient filament voltage) to the primary (if known,) and read the resulting voltages on other windings. This test set up is particularly helpful in avoiding handling lethal voltages when checking out high voltage transformers.



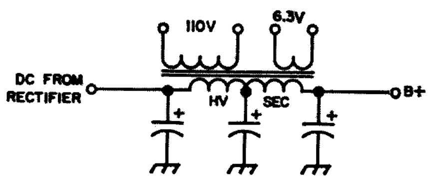
2. Power transformer for audio output.

Generally ½ of the secondary (hv) winding may be used as the primary to a single output tube, or the full winding to P.P. tubes and the 6.3 or 5v winding of the voice coil of the speaker. The 110v winding will handle a 600 ohm line, or headphones.



3. 600 ohm to 8 ohms, using power transformer or filament transformer.

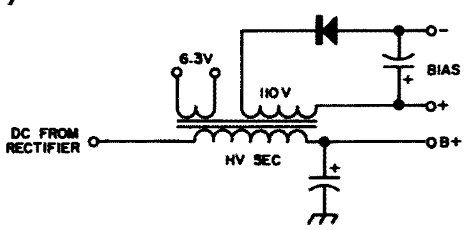
Use adequate size transformer. 110v to 600 ohm. 6.3v to voice coil. H.V. secondary (power transformer) unused.



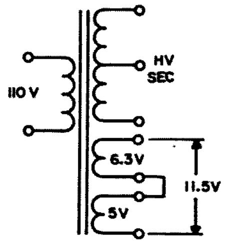
4. Power transformer as choke

Use secondary as a choke for hv supplies. Be sure current rating is high enough. Other windings unused.

5. Power transformer as choke and bias supply.

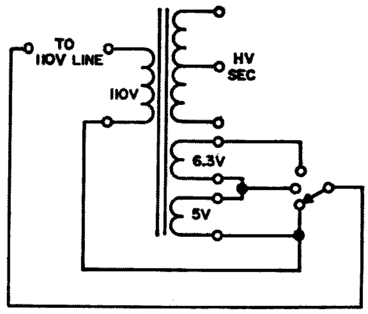


Connect choke input and rectify 110v winding for bias.



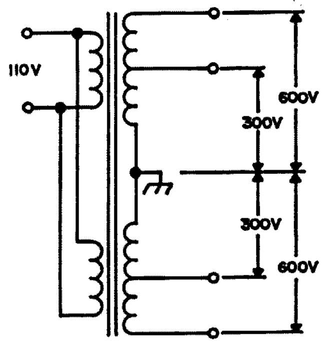
6. Series adding filaments

An oldie but a goodie for 12v filaments from 6.3 and 5v windings.



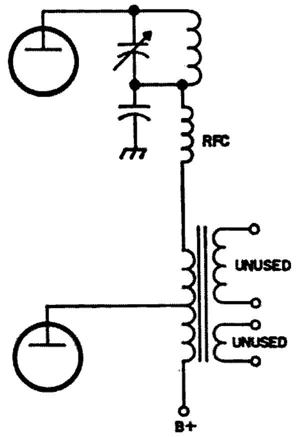
7. Filament windings to vary output

Here the filament windings are connected in phase, (or out of phase with the primary) to vary the hv as much as 20 to 30%. Test set up #1, is useful in determining phase.



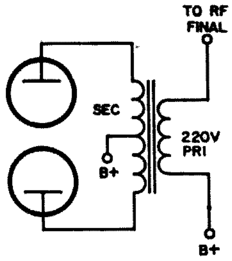
8. Series adding secondaries for high voltage.

Another oldie. Secondaries must be connected in phase. If more than two transformers are used, transformers must be mounted on insulating board and filament windings not used. Transformers vary greatly in breakdown point. Note half voltage may be taken from center taps if both supplies do not exceed current ratings.



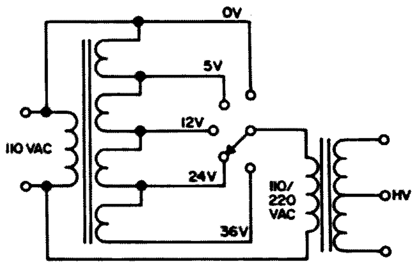
9. Power transformer as Heising modulation transformer

Requires a transformer of high current rating as power to rf final and modulator must be drawn through the winding. All other windings unused.



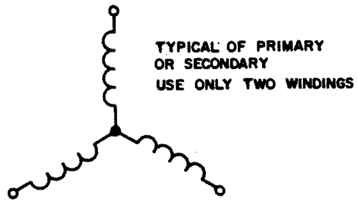
10. Power transformer as modulation transformer

Generally this application requires a rather low voltage secondary which is used as the modulator primary, and preferably a 200 to 240v secondary so the turns ratio is held as nearly as possible to 1-1. 110v TV transformers have been used successfully. Also 400 cycle transformers.



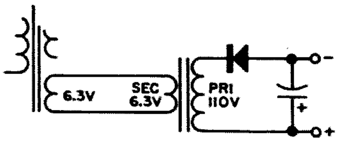
11. Filament transformer as Variac

The same circuit may be used in series subtracting for lower voltage from the transformer. This circuit should find wide application in using 200v Surplus transformers on 110v. Many heavy tapped low voltage transformers are available through MARS or surplus sales.



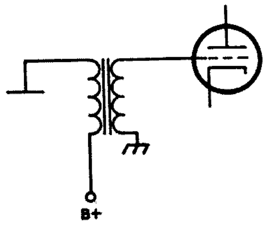
12. 3 phase transformer on single phase

Use only two of the three delta windings. Use the test set-up to check. One winding will be found to cancel both on primary and secondary if delta wound.



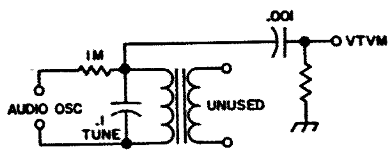
13. Use filament transformer reversed for bias supply.

Don't over look the fact that unlike filament voltages can be connected together for different output voltages. For example a 12 volt winding to 6.3 supply to get approx. 60 volts from 110v winding of transformer. Small power transformer can also be used with hv winding unused.



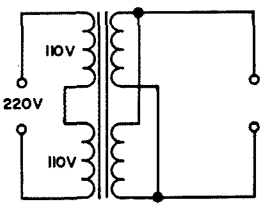
14. Isolation or bias transformer as interstage audio.

Surplus 400 cycle and 220v bias transformers are ideal here. Use lowest turns ratio as primary and highest as secondary. Should be 1-1, 1-2, or 1-3 ratio.



15. Transformers as audio filters.

All transformers have resonant frequencies. A little trial and error with fixed capacitors, an audio oscilator, and vtvm may provide you with that sharp or band pass filter you need.



17. 110v transformers on 220v.

Series the primaries and parallel the secondaries. The same circuit may be used on 110v if half voltage is needed. Series primaries and series secondaries may be used for double voltage from hv on 220 volts.

. . . W4LLR

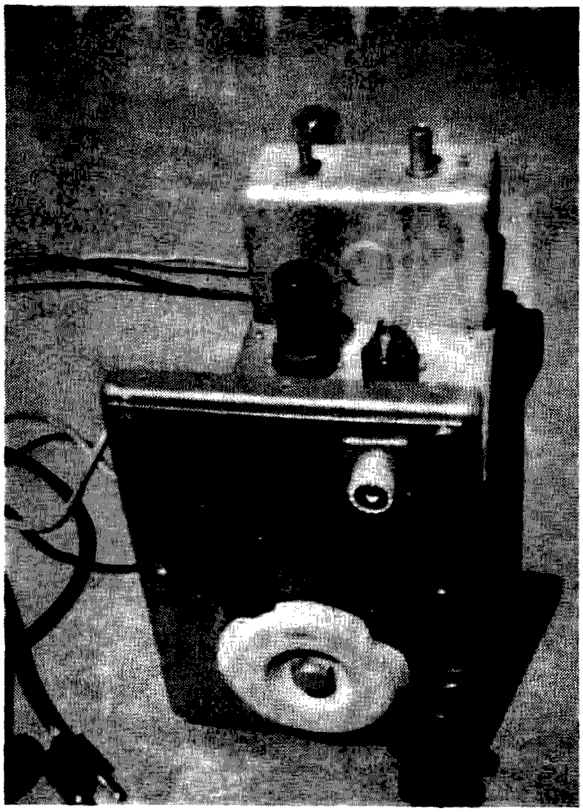
SB2-LA Note

Your 6JE6 tubes will last a lot longer if you reduce the static plate current to 200 mA instead of the 300 called for in the manual. This reduces the plate dissipation from 240 watts to 160 watts for the six tubes, each of which is rated at 30 watts.

. . . K6SHA

CORRECTION

On page 69 of February, change #2 in column 2 to IEE instead of IEEE. The reference was to the British Journal.



Clifford Klinert WB6BIH
520 Division St.
National City, Calif. 90250

In my version a 6SA7 was used as a mixer and a 6J7 was used for the rf amplifier. A VR-150 was added to provide stable plate voltage for the oscillator, a 6J5. Standard circuits were used, and each constructor probably has his own ideas about what circuit is the best for him, or his junk box. An ideal approach would be to use a 7360 to avoid the rf stage, and perhaps a complete receiver could be built on the chassis.

All components not related to the VFO were removed, with the exception of the PA tuning capacitor, C-65. This supports the dial and tunes the mixer's seven MHz. input circuit. The top of the chassis was cut out and a panel was mounted in its place to provide a chassis for mounting components. The grid circuit of the rf stage was kept above the chassis. The front panel was replaced in a manner similar to the chassis top, and all holes were filled with automobile body putty. The panel and sides were sanded, painted with a spray can, and the controls labeled with decals. The chassis with the power supply, *if*, and audio circuits was placed away from the operating table in a convenient place. The two units were connected with one cable carrying voltages for power, and a lead from the rf gain control mounted on the converter panel. A length of RG-58 was used for the *if* output lead.

Thus, our venerable friend the ARC-5 transmitter has provided a simplified and inexpensive approach to receiver front end construction.

. . . WB6BIH

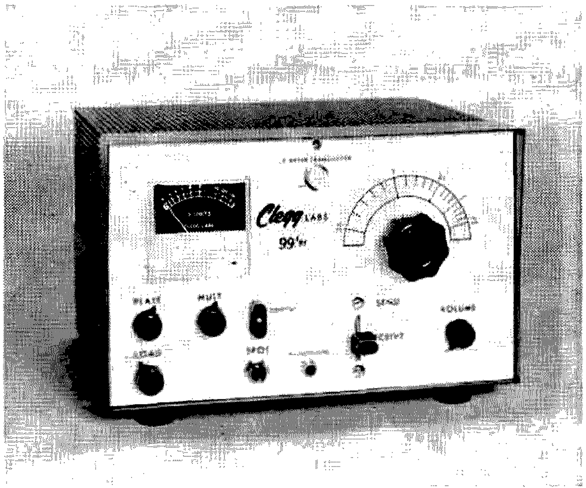
The ARC-5 Transmitter Receiver

Countless articles have been written on the conversion of ARC-5 and BC-458 transmitters. Much time and effort have gone into making these units operable on amateur bands. Often components are removed for use in other circuits, but a use for the complete chassis with a majority of the components still in place is always more attractive.

The 5.3 to 7.0 mHz ARC-5 transmitter provides an unavoidable opportunity for someone who has been thinking about building his own receiver, but is discouraged by the cost and difficulty involved in the mechanical construction of a stable high frequency oscillator. I was in this position a few months ago. A product detector, crystal controlled BFO, and high selectivity FT-241 crystal bandpass filters were added to an old S-20R, but a stable front end was still needed. The ARC-5 provided the answer. Tuning just below the forty meter band, the VFO provided a stable and calibrated means of tuning a forty meter receiver. Converters can be added for other bands.

Modifying

The Clegg 99'er



Paul Porcaro WB2JOS
106 Bleecker Street
Brooklyn, N.Y. 11221

Most hams are experimenters, and are constantly modifying their equipment. Two of the most popular pieces of amateur gear at present, are the Heath "Twoer", and the "Sixer", and articles concerned with increasing the capabilities of these "Lunchboxes" have been widely published.

There has been relatively little material devoted to showing how to modify the Clegg 99'er, and my purpose here is to show some really simple changes for this rig.

Changing this already "Hot" little set into an even "Hotter" one can be accomplished both easily and inexpensively. I will take you step by step, and show how the input power can be raised from 8 watts, to something a little over 15 watts. That's a gain of approximately 3 db.

Starting at the final, change the screen grid resistor (R32), connected to pin 8 of the 7558 (V9), from 33,000 ohms to 10,000 ohms, 1 Watt. With this change the final will draw more current, and the input power will increase.

Moving along to the audio section, we find that the Clegg 99'er has such excellent audio action that not much has to be done here. Just to be on the safe side however, change the 330,000 ohm resistor (R43), connected to the plate of the 12AX7 (V7A), pin 1 to 470,000 ohms. This change will increase the audio sufficiently to fill the carrier.

Now to probably the most important modification. Remove the rectifier tube 6BW4 (V10), and leave it out, it won't be needed any more. In its place install two silicon diodes. Sylvania F8 diodes worked out well for me. But any with similar or higher ratings will also work well.

One of the diodes is soldered between pin 1 and pin 9 of the 6BW4 (V10) tube socket, and the other diode is soldered between pin 7 and pin 9 of the same tube socket. Be sure to observe polarity, and don't forget to use a heat sink when soldering.

This last change will increase the B+ throughout the set, due to the lower voltage drop of the diodes when compared with the 6BW4 rectifier tube. With this increased B+ voltage, the rig will now have about 15 watts input. As an added bonus, the increased B+ will also hop up the receiver section.

To increase the efficiency of the Clegg 99'er still further, replace the 6AL5 (V5) detector and ANL with a pair of solid state diodes. This will save a little filament power.

To accomplish this task, solder one diode from pin 5 to pin 2 of the 6AL5 tube socket. Now solder another diode from pin 7 to pin 1 of the same tube. Remove the 6AL5 and leave it out. The diodes I used for this purpose were 1N198's, but any general purpose diodes having a good front to back ratio will do the job.

Every little bit of efficiency gained is a big help, especially if the rig is to be used mobile.

Want some proof of performance? The modifications I have described were incorporated in my own rig in September of 1963, and it is still operating as well as it always has. I think this test period is really long enough to prove that no great harm will be inflicted on the gear.

Good Luck With Your Higher Power!

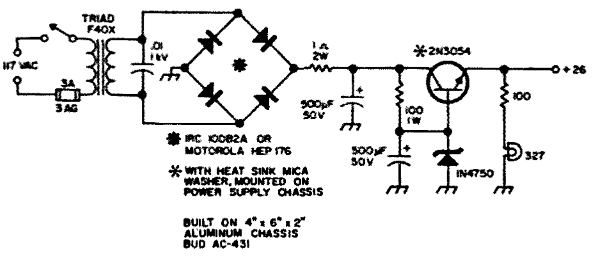
Modifying The BC1206

Hank Olson W6GXN
3780 Starr King Circle
Palo Alto, Calif.

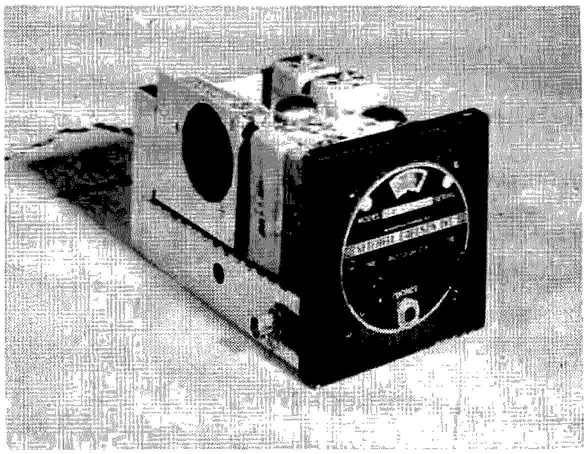
At first glance at the BC1206 receiver, it would appear that this 200 to 400 kHz receiver is of solid-state design. After all, it runs directly on +28 volts dc, makes no vibrator or rotary converter noise, and it is only 4 x 4 x 6⅝ inches in size. Yet this tiny lf receiver is really a tube-type design, using five Loctal type tubes. The plates of the tubes are supplied directly from +28v, very much as many auto radios operated directly on 12 volts, which were built in the early 1960's. (these auto radios were the so called "hybrids" using tubes in the rf and *if* circuits and transistors in the audio stages). Apparently, the BC1206 was twenty years ahead of its time!

If one can power the BC1206, it makes a worthwhile lf receiver for monitoring the FAA weather broadcasts. These broadcasts give continuous weather summaries and also give forecasts which may be of interest to amateurs.

The set may be used with all of the original tubes in it, but then that wouldn't be "converted", would it? You can save a lot of current and get much better audio by taking out the 14R7 detector and first audio stage and the 28D7 (probably the world's oddest receiving tube!) audio output. Replace the 14R7 by a 1N270 or similar germanium point diode, connecting the output of T5 through the diode to ground. The 14A7 filament depended on the 14R7, so replace the 14R7 filament with a IN2976 Zener, the anode (stud) of the Zener being bolted to the chassis. Bypass the Zener with a 50 mfd 15 volt capacitor. This point can be a source of 12 volts for the new audio amplifier.



Power supply for the BC 1206 built on a 4 x 6 x 2 inch aluminum chassis.



I used the audio section from an old Japanese transistor radio. I changed the transistors to NPN germanium units (2N388) so it could work from the plus 12 volts. The HV15 bias compensating diode is left in, but turned around for polarity.

A small speaker is added inside the case so that you don't have to use phones.

Since the total dc current required by the converted BC1206 is only about 350 mA, it can be operated from a relatively small power supply. Such a +26 volt, regulated supply is shown in **Fig. 1.** The power supply uses an emitter-follower series regulator which not only regulates the output dc voltage, but acts as a "capacity multiplier" to smooth out 120 Hz ripple.

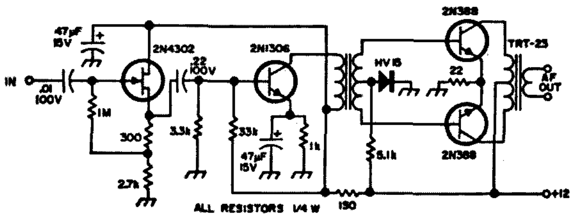
The antenna jack was changed to a type BNC. A UG 1094/U fits the ⅝ inch hole left after removing the original bayonet-style fitting.

Since the audio amplifier has an input impedance of only a few thousand ohms it would load down the detector and agc line. To prevent this, a simple FET source-follower precedes the amplifier, offering a very high input impedance to the detector.

If it is contemplated building the amplifier from scratch one could use a IN2326 (R.C.A.) as the compensating diode, and Lafayette 99R6126 and 99R6129 as the driver and output transformers.

The amplifier was built on a piece of

vector multihole circuit board (Vector 85G24WE) that was 2¾ x 2⅛, using Vector T28 pins. The amplifier board was mounted, on edge, behind the speaker in the space left by the 28D7 and its output transformer. The speaker is a 2 inch, 8Ω type; it was removed from the same Japanese transistor radio from which the amplifier parts were taken. 13 additional holes were drilled in the BC1206 cabinet, to allow sound to pass out the side of the receiver.



AF section of a typical Japanese transistor radio as modified for use in the BC 1206.

Finally, while you have the receiver "opened-up" you might just as well replace the four or five paper tubular capacitors that are easily accessable. 100 volt mylar-type capacitors are perfect for this, being smaller than the original and more adequate in voltage rating. The total capacitor cost will be less than a dollar for this "stitch in time", and will save time in the long rum.

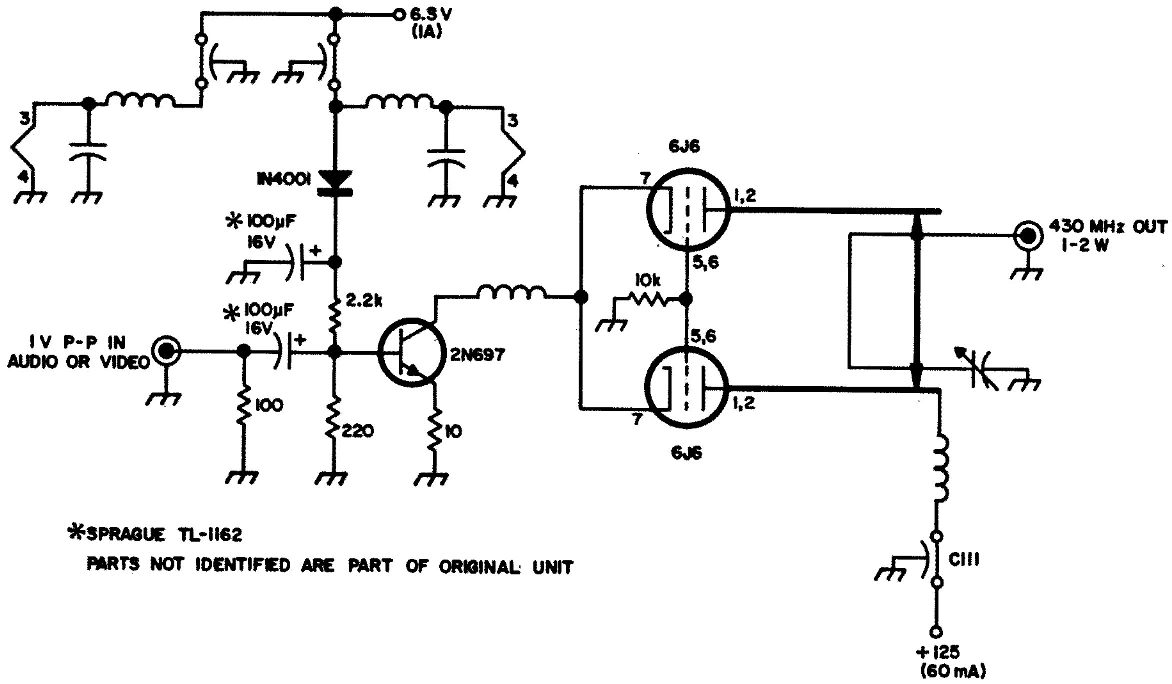
The modified BC1206 has proved to be quite satisfactory for receiving OAK on 362 kHz some twenty miles distant. In addition to the weather station OAK, perhaps another half dozen MCW signals can be heard. These other stations are probably marker beacons. . . . W6GXN

K3OLG Hears S-O-S

Jerry Lewine K3OLG was just tuning around a few weeks ago when he heard an S-O-S coming through on CW. He called the local Coast Guard just in case they didn't have the word. Turned out that they didn't and that Jerry's quick action helped 32 crew members and three passengers be saved from a burning Greek ship about 650 miles off the coast of Southern California.

APS-13 ATV Transmitter

Tom O'Hara W6ORG
10253 East Nadine Street
Temple City CA 91780



The APS-13 has been around for a long time in the surplus houses for about $2 each. The Tail-end Charlie, as it has been nicknamed, was used in the tails of B-17's to detect approaching aircraft. It contains both a transmitter and receiver. The receiver is not worth the effort to convert for video as the 30 mHz *if* strip and 430 MHz converter module are very noisy by present day standards and aren't wide enough in frequency response for good TV resolution. It does work fair for audio, with some work. The transmitter module can be dug out of the unit with a little prying, cutting, and unscrewing. The module has two 6J6's on top, cocked at an angle. It was originally used as a pulse modulated oscillator. This conversion changes it into a cathode modulated continuous running oscillator.

Modification

Change the grid resistor from 270 ohms to a 10K ½ watt. Remove the 39 ohm cathode resistor. Ground pin 4 of the 6J6's socket. Jumper the filaments together at the capacitve feedthroughs. Remove the tube shields and the part that holds them by twisting with a pair of pliers. This is necessary to raise the frequency to 430 MHz as they added too much capacity. Set the sliding short on the plate lines to about ⅜ of an inch from the end.

Construct the transistor modulator and bias supply on a 1 x 1½ piece of vector board. Mount a UHF chassis connector for the video input on the side opposite the UHF connector for the rf output. Mount the completed transistor modulator board against the side next to the input UHF connector on the inside. Connect the free end of the cathode RFC directly to the collector of the 2N697. Connect the rectifier diode IN4001 to the 6.3 vac filament feedthrough capacitor. Connect a ground lead and video input lead to the UHF connector. All leads must be direct and short. The power required is 125 vdc at 60 mA and 6.3 vac at

1 amp. These leads connect on the outside of the can to the feedthrough capacitors.

Operation

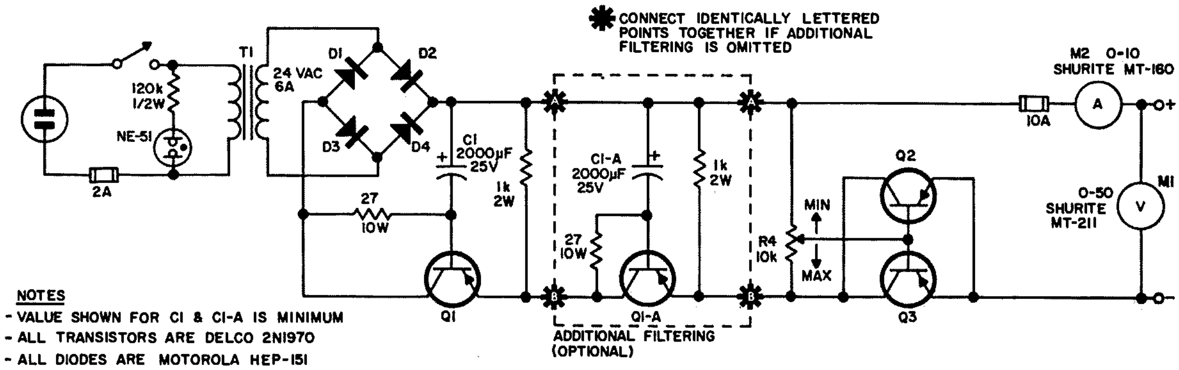
Like all modulated oscillators, rf loading affects the linearity of the modulation. TV is much more critical than voice. Consequently, the maximum power out does not necessarity correspond with the best picture. The power supply plate voltage must be in the range of 100 to 150 volts. The loading capacitor on the pickup link should be adjusted for the best received picture on a set located at least ¼ mile away. If you try to do it in your own shack you may get a bad picture from front end overloading. Try changing 6J6's also, as some work better at 430 MHz than do others. So far, the best has been 2 watts output, which put in a good picture 27 miles away. It's just the thing for portable and field day operation.

If you don't have a receiver for ATV on 430-440 MHz it is much easier to convert a commercial UHF TV converter than it is to play with the one in the APS-13. For most commercial UHF converters it usually only takes a one pF capacitor across each tuned circuit to tune it down. If you are low enough it will move the channels up 10 (channel 34 tunes in at 44 on the dial). If you can't see your carrier below channel 14 from the ATV transmitter or the third harmonic of a 2 meter transmitter, it could be that the local oscillator dropped out. In that case add a 1 pF capacitor in the feed back path (plate to cathode, etc).

The Blonder-Tongue model 44 tunnel diode Ultraverter is excellent for ATV as it has two variable capacitors which you can adjust in order to lower the frequency. Add an antenna, preferably of the broadband type such as the Cushcraft 16 element collinear CL-416, and you're ready to go.

This is the easiest and cheapest way to get on ATV, you also need a camera, flying spot camera, or color bar generator. Our audio is usually on two meters, on 146.7 for Techs and 144.45 for Generals. You can put audio on another APS-13 by adding a carbon mike and 150 ohm bias resistor, disconnecting the 100 ohm resistor, and hooking up the mike to the video input, which requires 1 volt p-p of video or audio. *See you on the air.*

. . . W6ORG



NOTES

- VALUE SHOWN FOR C1 & C1-A IS MINIMUM
- ALL TRANSISTORS ARE DELCO 2N1970
- ALL DIODES ARE MOTOROLA HEP-151
- FOLLOWING PARTS AVAILABLE AT INDICATED PRICES FROM BAY ELECTRONICS, 2315 ARTESIA BLVD, REDONDO BEACH, CALIFORNIA, 90278 (ADD POSTAGE)

C1, C1-A (25,000 uF 25V)	2.88 EA
D1,2,3,4	.79 EA
Q1, 1-A, 2, 3	.99 EA
T1	6.68 EA

Versatile Variable Power Supply

Ray Couch W6SLP
2610-182nd. Place
Redondo Beach, Calif. 90278

How often have you picked up some goodies at the local surplus market and rushed home to hook it up for trial, only to find that your 12 volt car battery or battery eliminator did not supply enough of the 24 volts needed to make it go? Or when the kids' transistor radio quit working, did you run all the way down to the radio store and buy a new battery only to find that it wasn't the right battery after all? The variable power supply described here can help you out of these situations as well as many others. You can even toss the battery eliminator out and use this unit to charge the jalopy battery, or convert the eliminator into the type of supply described here, using many of the original components.

This supply is simple to construct, small in size (I built mine in a 9" x 6" x 5" box, with room to spare), economical to build (if you have the major components in your junk box), has very smooth control, good regulation and excellent filtering.

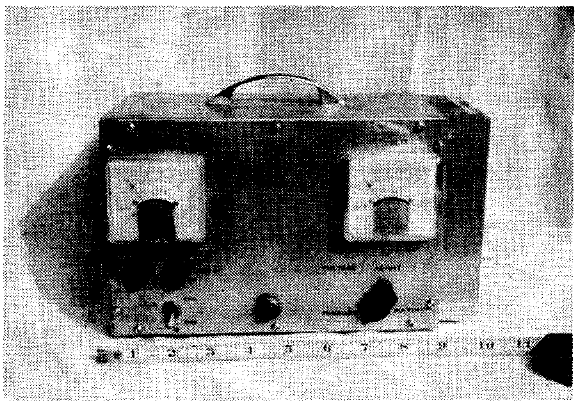
I was able to salvage all of the needed components from my junk box with the exception of the 10k linear potentiometer. Many of the components I used were not labeled as to part number, manufacturer, etc., but their ratings are similar to those shown. I should also mention that this same circuit can be used for supplies other than 0-24 volts, just don't exceed the voltage and current ratings for the diodes and transistors used.

About the Circuit

T-1 as shown on the schematic is hooked up to a conventional bridge rectifier circuit. If you happen to have a center tapped secondary transformer and only a couple of diodes, the circuit will work just as well with that arrangement. Likewise, a higher voltage transformer up to about 50 volts would make the supply even more useful (I used a 36 volt 5 amp. transformer).

The first transistor, Q-1, is the filter regulator part of the circuit. It is hooked up in what is sometimes called a capacitance multiplier circuit. That is, the filtering at the points marked A and B on the schematic is equal to the beta of Q-1 multiplied times the capacitance of C-1. For instance, if the beta of Q-1 is 40 and the capacitance of C-1 is 2000 mfd, the dc output is filtered to the equivalent of an 80,000 mfd capacitor across the output. This part of the circuit can also be duplicated to give still additional filtering. If you have no 2000 mfd capacitor, but do have a couple of 500 mfd capacitors, rather than parallel them into a single unit, use one in the base of Q-1, add another transistor and use the other capacitor in its base circuit. This will give you the equivalent filtering of 50 mfd times the beta of Q-1 (40) or 20,000 mfd. The additional transistor will give you an additional 20,000 mfd equivalent, and will also improve the regulation somewhat.

The second two transistors, Q-2 and Q-3, are the voltage control transistors. Two transistors are hooked in parallel to allow for the power that must be dissipated in that part of the circuit and will change with the change of voltage control R-4. If necessary a third or fourth transistor can be added in parallel with Q-2 and Q-3 if your transformer is capable of higher current output than 5 amps. In that case additional transsistors will have to be parallel with Q-1 also. On the other hand, if your transformer is only capable of a couple of amps., a single 2N1970 will suffice. Even a cheaper transistor such as the 2N307A may be used for Q-1, Q-2 and Q-3 for lower voltage, lower current requirements. In any case, all



The heat sink for Q-1, Q-2 & Q-3 can be seen attached to the right hand side of the case. The ammeter is on the left and voltmeter on the right. Output terminals are the two binding post below the ammeter, with the power switch just below them. The pilot light is at the bottom center. The voltage control potentiometer can be seen at the bottom right hand side below the voltmeter.

three transistors should be mounted on a good heat sink as they will run warm. You don't have to be fussy about components to build yourself a good well filtered power supply. Take inventory of your junk box, decide what voltages and current you would like to have, and if you have the transformer to fill this requirement you can use almost any type of diodes, transistors and capacitors by using them in series, parallel, etc., to fill the current and voltage requirements. Uses for this supply are limited only by the imagination. The filtering is sufficient to allow its use for transistor radios, tape players, etc., yet it has enough current available to charge car batteries or run solid state mobile rigs on the workshop bench. ...W6SLP

Low-Cost Conversion Of Surplus Oscilloscopes

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There are many oscilloscopes available on the surplus market at bargain prices of ten to twenty dollars. These 'scopes either do not include power supplies, or have power supplies which operate on 400 cycle current.

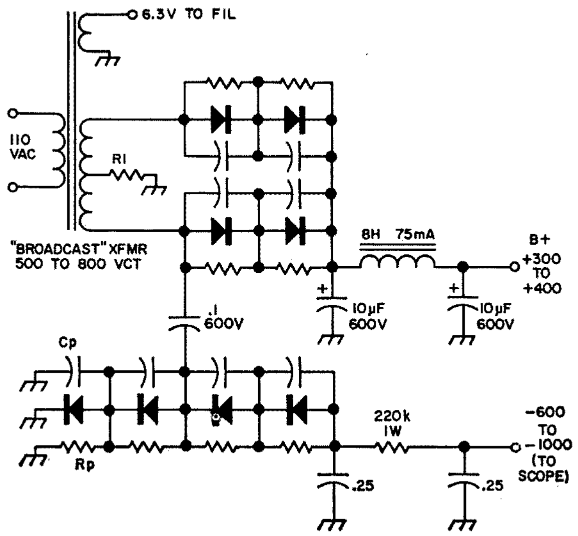
Past conversion articles invariably specified a new 60 cycle oscilloscope transformer in the conversion. Such transformers cost as much as the 'scopes, and the availability of transformers with the required voltages is limited.

This article describes an approach to power supply design which will supply all the necessary voltages, will fit into limited space, and best of all, cost the average amateur only a few dollars.

The design shown was built into a 1P-69/ALA-2 Panadapter. Silicon diodes eliminated the two rectifier tubes. This also eliminated the current demand of their fillaments. The space occupied by the tubes then became available for the new 60-cycle supply. This provided enough added space to allow the silicon rectifier board to be mounted vertically on the chassis. No butchery with the hack saw here. And, since tubes were eliminated, no heat dissipation problems developed.

The method of obtaining the high voltage, low current required for the cathode ray tube is not new. It has two very good features, however, that make it very desirable in this application. Voltages can be obtained from "broadcast receiver" type transformers, which keeps the cost down. Despite the simplicity, this circuit works reliably.

The transformer and filter choke can be taken from an old radio, hi-fi, or small TV set. The high voltage circuit for all circuits except the cathode ray tube is quite conventional. The use of two 600 volt PIV silicon diodes in series in each leg of the circuit provides protection against an inverse voltage of approximately 1000 volts quite adequately. If the builder prefers, three 400 PIV diodes may be substituted in each series string. While many power supply circuits do not include the .01 disc ceramic



capacitor and the ½ meg. resistor in series with each diode, it is recommended these be included to provide protection of the diodes.

The negative high voltage for the cathode ray tube is provided by a separate series of diodes. The low current demand of the cathode ray tube is supplied from the transformer through the .01 mfd 600 volt paper capacitor. The actual voltage measured in this circuit is almost 700 volts. Be sure the filter capacitors are rated for this kind of potential. In the original circuit these capacitors had a value of .25 mfd, 1000 volts.

Since the cathode ray tube has a high potential on the filament circuit, a separate filament transformer was used here. This filament transformer was rated at 1500 volts insulation, adequate to prevent breakdown. It may be possible to supply the filament with the extra windings on the broadcast power transformer (intended for the rectifier tube) without ill effects, but since I had a transformer available, this was not tried.

In the original circuit the 1000 ohm, 10 watt resistor was included in the center tap of the transformer to lower the voltage to 350 volts as shown. If this is not required, it can be eliminated. It does take up space, causes added heat, and adds to the power

demand on the transformer. This proved to be a small problem however, when compared to the expensive alternates available.

Detailed conversion of the 1P-69/ALA-2 was covered in an excellent article in the June 1964 Issue of 73 Magazine by William Parker. Anyone interested in conversion of this or similar panadapters are referred to that fine source. With the nomenclature shown in the wiring diagram, modification of the original power supply using the economical approach suggested here will be a simple matter.

In this, as in any conversion, I suggest that the first step of conversion be kept to the very minimum required to get the equipment working. Further conversion is easier and more interesting if you can see the step-by-step results.

With the above approach to oscilloscope power supplies, a bargain scope can be converted at a price proportional to the small scope investment. A bargain scope can truly remain a bargain! . . . W8JZI

Crystalize That FM Rig

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During my last two years in college I was associated with the manufacture of the equipment most available to the amateur FM enthusiast, Motorola Communications and Electronics, Inc. During this time I was besieged with many requests for information on the equipment available. Most of these requests were for one item, crystal information. Information on the oldest Motorola equipment such as the 30D, 16V, 5V etc. are easily available from places as FM Surplus Sales. However, the newer equipment now reaching the amateur market, 80D, 140D, T-33, T-43, T-41, T-51, T-44, etc. are not as easy for the average ham to find crystal information on. This information is available from most two-way radio shops, but, unfortunately many of these shops do not have the time or inclination to furnish amateurs with the necessary information. Of course there are many exceptions with many amateurs now working for and/or owning two-way radio shops, but these are still the exception and not the rule. Thus, I have written this article for 73 listing the transmitter and receiver types for 41 V and newer equipment with the respective crystal types.

These crystal types are designed to work in the circuit of the piece of equipment listed. However, other types may work if the circuit is modified. But, I strongly recommend that the correct type of crystal be purchased from a reputable supplier. International Crystal Company can and will furnish commercial grade crystals when given the Motorola type and the operating frequency (e.g. 146.940 MHz). In my opinion this is the best supplier. Commercial grade crystals cost more than the ordinary run-of-the-mill crystals or even the .005% crystals listed by many suppliers. Commercial grade crystals are .0005% or better.

For those amateurs who have many crystals, or who grind their own, or who just like to experiment, the crystal formulas for the respective types of crystals are also listed. Remember that even though the fundamental frequencies are the same, crystals of different types (cuts) will not necessarily operate on the same frequency when placed in a circuit designed for another type. However, it is possible to make some types pull onto frequency, but this sometimes requires substantial modification of the circuit. Therefore, if at all possible, use the correct cut of crystal.

Now, for those who feel they cannot complete modification of their equipment without help, please do not write me concerning your problems. I would like to help you very much, but my present schedule does not give me ample time. Information on conversion of many units is available from other sources. Included in these are the books published by FM Surplus Sales and others.

Now, to get down to business: The transmitter type of the respective unit is listed on the manufacturer's identification tag as "Trans Type" and the receivers are marked somewhere on the chassis. The transmitters also *may* have an identification number on the chassis, but this does not always hold true. Also, other identification numbers, not the transmitter type, are stamped on some chassis.

Well, here's the information everyone has been waiting for:

Transmitters Chassis No.	25-50 MHz Crystal type
TA 104	RN3
TA 105	RN3
TA 130	RN3
TA 169	RN3
TA 179	RN3
TA 180	RN3
TA 181	RO4
TA 193	RO4
TA 194	RO4
TA 200	RN3
TA 201	RN19
TA 202 series	RN19
PA 7203B	RO4
P 8620	SFMT3
P 8620B	RO6
PA 8625B	RO4
PA 8671 series	RO4
PA 8672 series	RO4
PA 8673 series	RO4
PA 8691 sereis	RO4
PA 8692 series	RO4
PA 8693 series	RO4
P 9030 series	R10
P 9050 series	R10
TTB 1011 through	
TTB 1016 AA, AB	RN3
TTB 1011 through	
TTB 1015 AC, AD	RN19
TTB 1021 AG to	
TTB 1026 AB	RN19
TTB 1031 AA to	
TTB 1036 AA, AB	RN3A
TTB 1036 AC, AD	RN19A
TTB 1041 to	
TTB 1046 AA, AB	RN3A
TTB 1046 AC, AD	RN19A

Receivers Chassis No.	25-50 MHz Crystal type
TA 108 (25-30)	R29
TA 108 (30-54)	R28
TA 111 (25-30)	R29
TA 111 (30-54)	R28
TA 111A (25-30)	R29
TA 111A (30-54)	R28
TA 111B (25-30)	R29
TA 111B (30-54)	R28
TA 111C (25-40)	RM14
TA 111C (40-54)	RM15
TA 162 (25-30)	R29
TA 162 (30-54)	R28
TA 162A (25-30)	R29
TA 162A (30-54)	R28
TA 164 (25-30)	R29
TA 164 (30-54)	R28
TA 164A (25-30)	R29
TA 164A (30-54)	R28
TA 165 (25-30)	R29
TA 165 30-54)	R28
TA 189	RO2
TA 189 A series (25-40)	RM21
TA 189 A series (40-54)	RM22
TA 189-R2	ZO3
TA 192	RO2
P 8028 series (25-44)	A14
*P 8028 series (39-54)	A14
P 8116A (25-44)	A14
*P 8116A (39-50)	A14
P 8116B (25-44)	R14
*P 8116B (39-50)	R14
P 8116C (25-44)	R14
P 8116C (39-50)	R14
*P 8116C (39-50)	RO2
PA 8619B	R14
PA 8633 series	RO2
PA 8633A (#2 Rx)	R32
P 8658 series	ZO2
PA 8663 series	RO2
PA 9034	RO8
PA 9034A, B, C, F (25-30) (40-50)	R16
PA 9034A, B, C, F (30-40)	R18
PA 9074	ZO4
PA 9074A, B, C (25-30)	ZO6
PA 9074A, B, C (30-40)	ZO7
PA 9074A, B, C	ZO6
PA 9137 A	RO2
PA 9145	RO2
PA 9146	RO2
P 9181	ZO2
PA 9219A	RO2
PA 9244 series (25-30)	R25
PA 9244 series (30-54)	R22
PA 9265	RO2
PA 9266	RO2
PA 9273	RO2
WE 9273	RO2
TRB 1050AA (25-40)	RM21
TRB 1050AB	RM22
TRB 1071 through	
TRB 1071 series (40-54)	RM/RP 15
TRB 1081 AA through	
TRB 1984 AA (25-40)	RM/RP 14
TRB 1081 AA through	
TRB 1084 AA (40-54)	RM/RP 15
TRB 1091 AA through	
TRB 1094 AA (25-40)	RM/RP 14
TRB 1091 AA through	
TRB 1094 AA	RM/RP 15

Transmitters Chassis No.	144-174 MHz Crystal type
TA 139 series	RS1
TA 170 series	RS1
TA 190	RO3
TA 192	RO3
TA 205 series	RS1
TU 402-C4	ASLX-1
TTD 1060 series	RN1A
PA 7291C	RO3
P 8320 series	SFMT-1
PA 8461 series	RO3
PA 8462 series	RO3
PA 8463 series	RO3
PA 8491 series	RO3
PA 8492 series	RO3
PA 8493 series	RO3
P 8520, A, B	SFMT-1
P 8520E	RO5
PA 8664B	RO3
PA 8665B	RO3
P 9020 series	RO9
P 9040 series	RO9
TTD 1000 series	RN1
**TTD 1020AA	RN1, RN1A
TTD 1044AA, AB	RN1
TTD 1060A series	RN1A
TTD 1070 series	RO3A
TTD 1080AA	RO3
TTD 1090 series	RO3
TTD 1100A	RO3
TTD 1120AA	RN1A
TTD 1140 series	RN1
**TTD 1240AA	RN1, RN1A
TTD 1320 series	RO3A
TTD 1330AA	RO3
TTD 1340 series	RO3
TTD 1350AA	RO3
TTD 1370AA	ZNN-1A
TTD 1137AD	ZNN1-1A
TTD 1380 series	ZNN1-1A

Receivers Chassis No.	144-174 MHz Crystal type
TA 101	R27
TA 140	R27
TA 140A	R27
TA 140B	RM10
TA 161	R27
TA 163	R27
TA 163A	RM10
TA 178	R27
TA 182	R27
TA 182A	RM10
TA 191	RM16
TA 191-R2	ZM16
TA 198-R3	RM10
TA 199-R4	RM10
TA 206	RM10
PA 7250 series	ZM16
PA 7251 series	ZM16
PA 7254 series	RM16
PA 7265 series	RM16
P 8328, A (152-162)	R14
P 8328B, C (152-162)	R14
PA 8433 series	RM16
PA 8438 series	RM16
PA 8443 series	RM16
PA 8476 series	ZM16
P 8528	R14
PA 9033	RO7
PA 9033A, B, F	R15
PA 9073	ZO3
PA 9073A, B	ZO5
PA 9147	RM16
PA 9148	RM16
PA 9243 series	R21
PA 9267	RM16
PA 9268	RM16
TRD 1040AD	RM27
**TRD 1011 through	
TRD 1022	RM10, RM10A
TRD 1031 series	RM27
TRD 1032 series	RM16
TRD 1041 series	RM27
TRD 1042 series	RM16
TRD 1051 series	RM27
TRD 1052 series	RM16
TRD 1080A	R15
TRD 1090A	R15
TRD 1100A	RM27
TRD 1111AD	RM10
TRD 1112AD	RM10A
TRD 1121AD	RM10
TRD 1122AD	RM10
TRD 1151 series	RM10
TRD 1152AA	RM10
TRD 1171 series	RM10
TRD 1172AA	RM10A
TRD 1181AA, AB	RM10
TRD 1182AA, AB	RM10
TRD 1260AA, AB	RM10
TRD 1311AB, AD	RM10
TRD 1312AB	RM10A

* Converted from lower frequency range (e.g. 25-44).
** A letter "A" following crystal type designates 12 V oven.

Crystal Type Formulas

Fx = crystal frequency in MHz
Fc = carrier (operating) frequency in MHz
Fi = 1st IF Frequency

Crystal No.	Formula
SFMT-1	$Fx = \frac{Fc}{48}$
SFMT-2	$Fx = Fc \pm 5\ Fi$
SFMT-3	$Fx = Fc/16$; $Fx = Fc/36$
SFMT-5	$Fx = Fc/24$; $Fx = Fx/32$
SFMT-6	$Fx = Fc/24$
AC-1 through AO-5 if Crystal	
AO6	$Fx = Fc + .455$
A14	$Fx = \frac{Fc - 4.3}{4}$
	$Fx = \frac{Fc - 4.3}{5}$
	$Fx = \frac{Fc - 4.3}{10}$
AM-9	$Fx = \frac{Fc - 8.045}{14}$
AM-12	$Fx = Fc - 4.55$
AM-13	$Fx = \frac{Fc - .455}{5}$
AM-18	$Fx = \frac{Fc - 72}{32}$
AN-1	$Fx = Fc/24$
AN-2	$Fx = Fx/16$
AULX	$Fc \pm .455$
ASLX-1	$Fx = Fc/24$
CO-1	$Fx = Fc/32$
CO-2	$Fx = \frac{Fc + 2.1}{5}$
CO-3	$Fx = \frac{Fc - 2.1}{6}$
CO-4	$Fx = \frac{Fc + 2.1}{4}$
CO-5	$Fx = Fc/18$
CO-6	$Fx = Fc/18$
CO-7	$Fx = Fc/18$
GO-1	$Fx = \frac{Fc + .455}{17}$
GO-2	$Fx = \frac{Fc\ (25\text{-}30) + .455}{4}$
	$Fx = \frac{Fc\ (30\text{-}40) + .455}{5}$
	$Fx = \frac{Fc\ (40\text{-}50) + .455}{6}$
RO-2	$Fx = \frac{Fc + 2.9}{3}$
RO-3	$Fx = Fc/24$
RO-4	$Fx = Fc/16$
RO-5	$Fx = Fc/48$
RO-6	$Fx = Fc/16$
RO-7	$Fx = \frac{Fc - 5.5}{5}$
RO-8	$Fx = \frac{Fc + 2.9}{3}$
RO-9	$Fx = Fc/24$
R10	$Fx = Fc/16$
R12	$Fx = Fc/36$
R13	$Fx = \frac{Fc + 5.5}{3}$
R15	$Fx = \frac{Fc - 8}{5}$
R16	$Fx = \frac{Fc + 4.3}{3}$
R17	$Fx = \frac{Fc - Fi}{8}$
R18	$Fx = \frac{Fc - 4.3}{2}$
R19	$Fx = \frac{Fc - Fi}{8}$
R20	$Fx = \frac{Fc + 4.3}{3}$
R21	$Fx = \frac{Fc - 8}{5}$
R22	$Fx = \frac{Fc + 4.3}{3}$
R24	$Fx = Fc/24$
R25	$Fx = \frac{Fc + 4.3}{3}$
R26	$Fx = \frac{Fc + 4.3}{3}$
R27	$Fx = \frac{Fc - 12}{5}$
R28	$Fx = \frac{Fc + 5.5}{3}$
R29	$Fx = \frac{Fc + 5.5}{3}$
R35	$Fx = \frac{Fc + 5.5}{3}$
R37	$Fx = Fc/144$
RM-10	$Fx = \frac{Fc - 12}{5}$
RM-14	$Fx = Fc + 5.5$
RM-15	$Fx = Fc - 5.5$
RM-16	$Fx = \frac{Fc - 5.5}{5}$
RM-21	$Fx = Fc + 2.9$
RM-22	$Fx = Fc - 2.9$
RM-24	$Fx = Fc + 5.5$
RM-27	$Fx = \frac{Fc + 5.5}{5}$
RN-1A	$Fx = Fc/24$
RN-3	$Fx = Fc/12$
RN-19	$Fx = Fc/18$
RN-20	$Fx = Fc/216$
RN-31A	$Fx = \frac{Fc + .455}{4}$
RN-32A	$Fx = \frac{Fc + .455}{5}$
RN-33A	$Fx = \frac{Fc + .455}{6}$
RN-34A	$Fx = \frac{Fc + .455}{16}$
RS-1	$Fx = Fc/24$
YM-14	$Fx = Fc + 5.5$
YM-15	$Fx = Fc - 5.5$
YM-29	$Fx = \frac{Fc - 12}{3}$
YM-35	$Fx = \frac{Fc - 11.7}{3}$

The author claims no originality in the above information. Crystal information for Motorola equipment appears in the catalogs supplied by Motorola to its authorized service stations. Also, the crystal formulas appear in older editions of these same catalogs. However, to my knowledge these formulas and lists have not appeared in full in any of the well-known amateur publications.

. . . K9STH/5

CLUB SECRETARIES NOTE

Club members would do well to get their club secretaries to drop a line to 73 and ask for the special club subscription scheme that we have evolved. This plan not only saves each club member money, it also brings badly needed loot into the club treasury, if desired. Write: Club Finagle, 73 Magazine, Peter Boro Ugh, New Ham Shire 03458.

Use of the Wilcox F3 as a WWV Receiver

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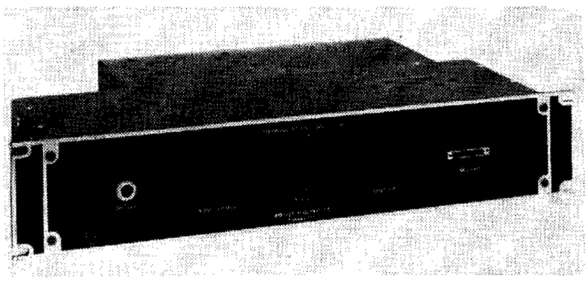


The Wilcox F3 and its sister receiver the CW3, are relatively old as military surplus items go. However, as fixed-frequency receivers they are quite adequate for WWV reception on 2.5, 5, 10, or 15 MHz. Having one of these receivers set up for the best WWV frequency at *your* QTH is a handy adjunct to amateur operation. This is true even if one uses a general coverage receiver, because then he doesn't have to tune "way down the band" to get WWV. The owners of "ham-band-only" receivers will welcome the F3 on WWV even more so.

My CW3 arrived sans *rf* coils and rectifier, but otherwise intact. Apparently the only schematic that is available, is for the F3 and it is in the Cowan "Surplus Schematics Handbook." This book lists the "groups" of frequency coverage (covering 1.9 to16.5 MHz in four " group"), and identifies the *if* frequency as 455 kHz. Table 1 shows which "groups" cover the various WWV frequencies.

Table 1

WWV Freq	Group	Frequency Coverage
2.5 MHz	#1	1.9 to 3.6 MHz
5 MHz	#2	3.1 to 6.1 MHz
10 MHz	#3	5.1 to 10.0 MHz
15 MHz	#4	8.1 to 16.5 MHz

Since no rf coils came with my CW3, the first order of business was to make some. It is apparently the coils alone which determine to which "group" one's receiver belongs. Coils were made for 10 MHz.

Three Amphenol 86-CP8 plugs (octal/male) were used as coil bases (old tube bases could have been used as well). L1, L2, and L3 (as shown in **Fig. 1**) were made from C.T.C. X2060-2 slug-tuned coils (3.5 to 7.0 μH). On each coil a #10 solder lug is mounted which electrically connects the threaded mounting to the nearest coil terminal. Then two pieces of #14 bare bus-wire are soldered into the appropriate pins of the 86-CP8 plug and also soldered to the coil ends. This provides both electrical connection and adequate mechanical support for the coils. The link windings on each of the three coils are then wound using #28 enameled wire, and the ends soldered into the plug pins directly.

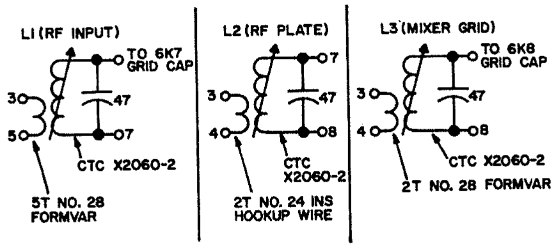


Fig. 1. Coil information

Replace the original antique crystal socket with an HC6/U crystal socket. Two pieces of #14 tinned bus wire are pushed through the pin holes of the existing FT249 socket and soldered *inside the chassis.* The HC6/U socket is then soldered to these wires on the outside, close enough to the old FT249 socket so that the crystal shield can will fit over an HC6/U crystal when in place.

To apply power to the receiver, and ac cord was made up using a Cinch-Jones S-304-CCT, and this connector plugged into P1 so as to connect the line to pins #7 and 8.

Coils L1, L2, and L3 were "tuned cold" using a grid-dip meter before the receiver

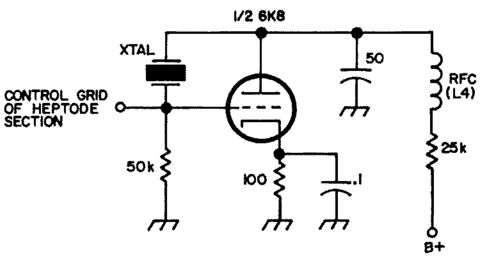
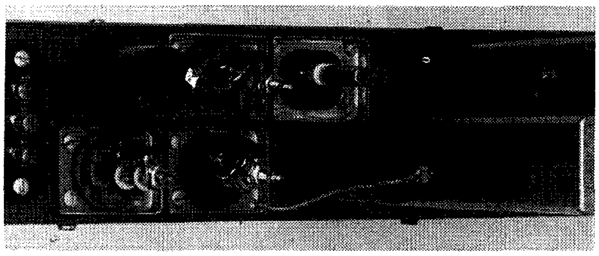


Fig. 2. Simplified oscillator circuit for the F3 or CW3.

was turned on. The crystal oscillator (half of the 6K8) is of the Pierce type and requires no adjustment. Assuming that the *if* is not out of alignment and that a good WWV signal is "in," one can tune up the receiver by just tweaking L1, L2, L3, and the *if* transformers for maximum audio output.

The crystal (10.455 MHz) was obtained from JAN Crystals for $2.55, ground to order. When ordering a crystal it is always wise to send a copy of the oscillator circuit. The simplified oscillator circuit of the F3 or CW3 is shown in Fig. 2, for use by the crystal company that you patronize.

A few additional notes about the F3-CW3 receivers may be in order. The type 80 rectifier tube is the oldest type in the receiver, and can be replaced (with a socket change) to a 5Y3GT. There are about half a dozen bypass capacitors (0.01 μF and 0.1 μF "micamold" types) in the original receiver, that are potential trouble sources. These ought to be replaced, simply as preventative maintenance, by 400v mylar types. Some surplus dealers still have coils for the F3 and CW3, and if you are worried about coil shielding (my unshielded coils gave no troubles), they can still be obtained for some frequency groups.*



Looking inside the F3

. . . W6GXN

*Red Johnson Electronics, 3311 Park Blvd., Palo Alto, California.

The Dollar Fifty-Super Nifty

Allan Joffe W3KBM
531 E. Durham St.
Phila, Pa. 19119

Through 73 Magazine I was introduced to John Meshna and this resulted in the chance purchase of what was described as "A brand new frequency determining network for use in Northern Electric Teletype converters." Price $1.50.

Among other goodies beside the grey box marked 1445 Cycles were two 300 Millihenry chokes plus assorted capacitors and connectors, which same made their way to the satin lined junk box, I felt that the 1445 cycle filter could be made into a good C.W. filter and the results achieved were very satisfying.

As Fig. 1 shows, I used the filter backwards, using input for output and output for input. This was the result of trial and error to make the gadget work. If you check the filter with an ohmmeter you will find dc continuity between OUT and COMMON but no dc continuity between IN and COMMON.

The capacitor, switched in and out by Sw-1, serves as a filter bypass if you wish to copy an AM or a SSB signal. It is also helpful in the CW mode to open your ears to a segment of the band to find the signal before you sharpen it. This filter is extremely sharp, with a measured bandwidth of about 50 cycles. This means that if your receiver is not stable, and I mean stable, you may not be able to enjoy the full benefit of the filter's possibilities. The converse is also true, if the rig sending the desired signal tends to drift.

Due to the extreme selectivity there is some ringing evident but this is much better than a jumble of signals blotting out the signal you want to copy, and this the filter will eliminate.

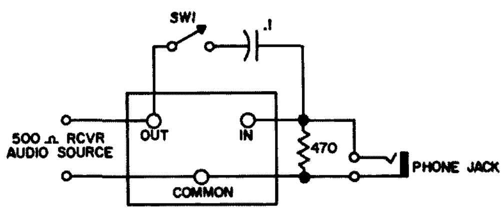


Fig. 1. See text.

As shown in the picture, my receiver is a Lafayette HA-350. The filter unit is the grey box sitting on top of the 73 magazine.

Since the HA-350 has a 500 ohm winding for audio, this was used to feed the filter. The 470 ohm filter termination seemed to have the effect of reducing the "ringing" encountered without affecting the selectivity of the unit.

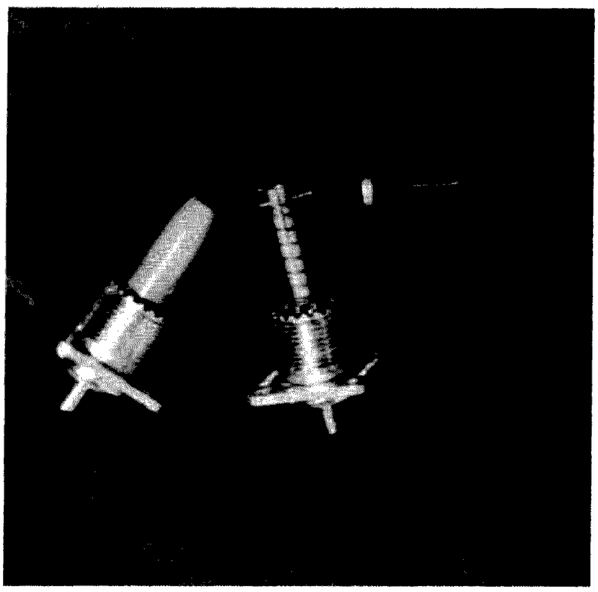
. . . W3KBM

D. E. Hausman VE3BUE

Banana Plugs Fit Into Coax Jack

So you just got that new receiver, and being a typical ham, you found to your dismay that your junk box held nothing resembling a PL-259 coax plug with which to connect your sky wire to the receiver. In accordance with Murphy's law, you decide that you want to connect that experimental circuit to a piece of gear with only an SO-239 jack as an input connector; of course you are too lazy to disassemble a coax plug and solder the blasted thing into what is only an experiment!

If the above sounds like you, there is no need to dispair. The simplest and easiest thing to do is to use a common banana plug instead of the PL-259. The banana plug fits nicely into the coax jack as does a 'no solder' post scrounged from an electronics educational kit. In order to ground the connection, loosen one of the four screws holding the SO-239 and fasten the ground conductor to it.



Either a banana plug or non-soldering terminal may be plugged directly into an SO-239 jack with no modifications.

Another advantage of this kink is that it can be used with *all* kinds of cable and wire—not just one or two types of coax.

Restoring Old Equipment

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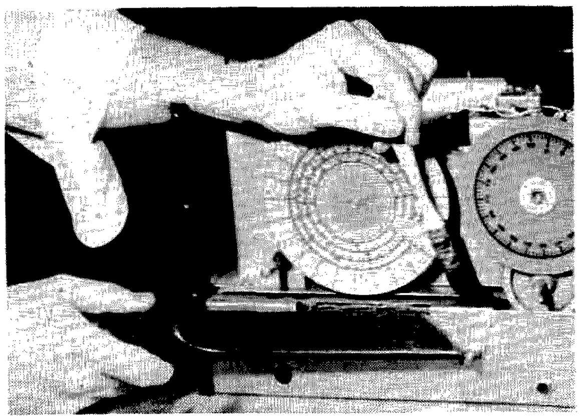
You know the feeling. I mean the one you get when you are browsing through an unfamiliar radio surplus store and you suddenly come across a little gem of radio gear that you have always wanted to own. The pulse rate goes up a notch and the hair on the back of your neck bristles a little. In order to get a better look you gently remove a layer of other old chasis—maybe "carcasses" is a better word—and uncover the whole gem. "Is it too far gone or can it be made to play?" you ask yourself.

Inside of you a battle begins. Hope tells you that the gem is in working order. Your ego says that whatever is wrong, you can fix it. Experience tells you to grab your wallet and run, do not walk, to the nearest exit. As a compromise, you turn the gem over and look at the wiring on the bottom side of the chassis. Well, well; not too bad. And no obvious signs of modifications. Back to the top. Some tubes gone; minor dents in i.f. cans. And the panel is hopeless. Hmm . . . look around; maybe there is another one in better condition. Nope. You approach the dealer warily and indicate lukewarm interest in an old receiver chassis. Without knowing which one you have in mind he will say something like: "That's a three hundred dollar instrument." You counter with: "It's a basket case now; utterly hopeless." You know how the script goes. Each of us has his own approach to a deal; it always ends with the dealer pocketing the money and you hoping that you can clean the beast up a bit before the family sees what you paid good money to get.

A lot of man-hours are spent every year fixing used or war surplus equipment. More often than not, the gear is some kind of a receiver or uses receiver-type circuits. Having restored many sets over the last quarter of a century I have had an opportunity to learn a few lessons the hard way. I have also learned that you can develop an order of procedure that will work well with almost any item of electronic equipment. My recent experience was so typical that it should serve as a step by step guide for anyone who hasn't done this sort of thing before but is ready to try.



Brush and vacuum are used for the initial cleanup.

The little gem that I took home in the back of the family station wagon happened to be a Hallicrafters S-36. Made around 1940-1945 this receiver tunes from 28 to 144 megahertz in three bands. It has both AM and FM detectors; a bfo is provided for receiving code. I wanted the S-36 to complete a set of consisting of an SX-28, an S-36 and an AN/APA-10. Many of you will remember that the APA-10 is a panoramic receiver that was designed to work with airborn versions of the S-36 and the SX-28 which were designated ARR-5 and ARR-7, respectively.

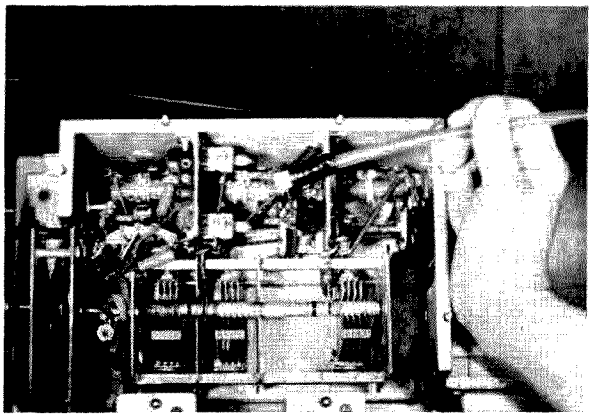
In addition to tuning across the ten and six meter bands it would cover the 42 MHz output of a vhf/uhf television tuner. I intended to use the tuner as a converter for two meters and the higher frequency bands. As you can see, my potential uses for the S-36 would justify spending enough time on the restoration to do the job properly.

Mechanical work

The restoration began with the removal of the knobs and the front panel so as to permit cleaning away dust and foreign matter. A tank vacuum with its crevice tool is excellent for this work. As shown in **Fig. 1**, a small, dry paint brush will loosen surface dust, helps in cleaning threaded parts, gets dirt that hides between *if* cans and is useful in joints and corners. I do *not* recommend blowing dust off with com-

pressed air as it can be damaging. I have seen the mica insulation blown out of a compression trimmer capacitor when it was used. If dust can be removed no other way, use the low pressure stream from the tank vacuum (you put the hose on the other end of the tank) and be careful! If any iron filings are present they can be removed with a small magnet. Cover the magnet with a piece of plastic to make its cleaning easier. Of course, a thorough cleaning of the set will require that all of the tubes and any other plug-in components be removed. In older equipment each tube socket is usually marked with the tube type number. If the socket is not labeled it is a good idea to make a diagram showing the location of each tube as it is removed from its socket.

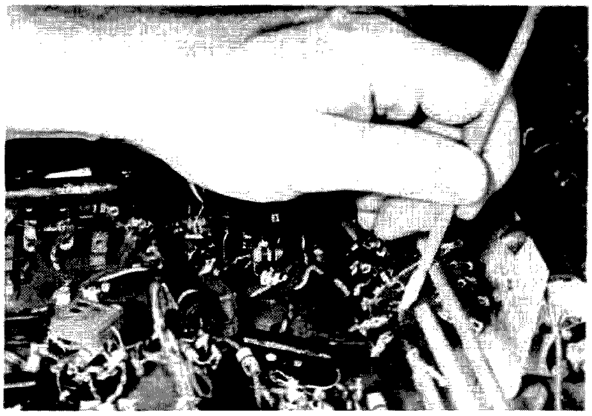
As a rule, the case, front panel and side braces can easily be removed from the chassis. They are cleaned by immersing them in



A special brush was made to extend the vacuum into tight spots.

a hot solution of household detergent and scrubbing them with a bristle brush. If you rinse them in hot water and dry them immediately they won't rust. The knobs, nameplates and dial escutcheons can be given similar treatment. Bakelite parts should be dried with a soft cloth, preferably flannel.

You may have to deal with dented *if* cans. If the dents are minor they are best left alone. Larger dents may detune the transformer and may be associated with internal damage. If this is the case, remove the transformer carefully from the chassis and then slide the parts out; try not to force anything. After taking the dents out of the shield, the core and windings should be inspected. Check the trimmer capacitors and test the windings for continuity with an ohmmeter. If permeability tuning is used, be sure that the tuning slugs have not become detached



Silver cleaning solution is applied to plated switch contact with a cotton swab.

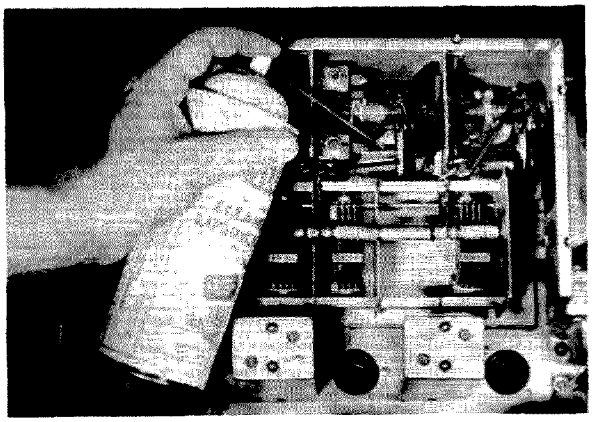
from the threaded rods. Cement them back in place if they are loose. Remove any small chips of ferrite material.

Be careful when you are vacuuming underneath the chassis. Use a brush to get at the dirt; move the wiring harness and components as little as possible. Hookup wire seems to get brittle with age and it breaks easily; not in the middle but where it is soldered to a terminal or where it has been bent sharply. Be willing to suspect any lead of being open when you are trouble shooting.

I don't advise any removal, bending or other disturbance of the rf coils in a vhf receiver. Don't even straighten out bumps or unevenness in the end turns unless you are *sure* that they are the result of accidental damage. They may have been put there during manufacture to adjust coil inductance. It is similarly unwise to straighten the end plates of variable capacitor rotors. They are often slotted to permit minute adjustments of circuit capacity at several points across the tuning range for proper tracking.

To help clean the rf coil compartment I made a tubular brush out of firm ½" plastic tubing, bristles from an old brush, string and glue. The brush is connected to the vacuum cleaner hose by means of a cork that has been drilled to accept the plastic tubing. The plastic tubing should not be longer than ten or twelve inches if strong suction is to be maintained.

After the set had been cleaned I looked it over for mechanical troubles and found a common one. When the tuning capacitor was fully meshed the dial was obviously not at the low-frequency end of its scale. Inspecting the gear train and shafts disclosed a flexible coupling with loose set screws. I loosened it further so that I could move it



Wafer switch contacts are lubricated with a silicone spray.

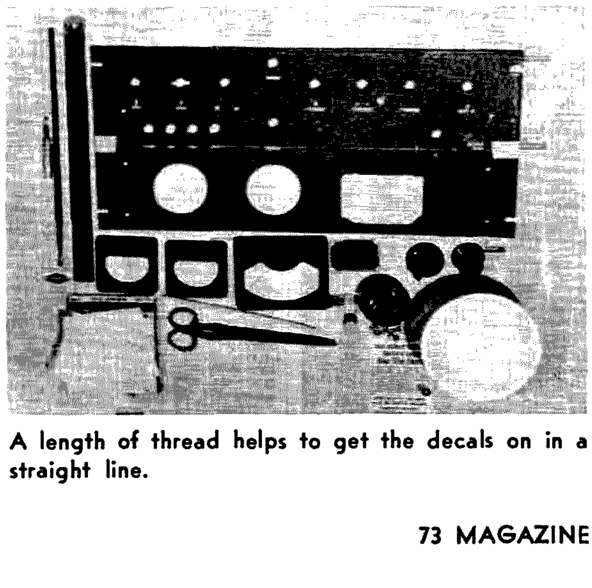
enough to see the marks made on the shafts by the set screws when the set was manufactured. That helped in restoring the shafts to their original relationship. With a little care you can get setscrews to seat in an old depression. I was lucky; when the work was finished the dial and the tuning capacitor were in proper alignment.

At this point in the restoration of a set you can check it for loose mounting screws, bent brackets and general wear and tear. You can replace worn dial cords, install new controls to replace any having bent or broken shafts and replace broken antenna or loudspeaker terminals. Look at all of the capacitors, too. Some of them may be leaking oil or electrolyte. Wax dripping from a tubular capacitor may be a sign that it is passing some direct current and heating up as a result. Replace it if that is the case.

Electrical Tests

The set had not yet been engergized and I wanted to apply power as carefully as possible. Of course, anyone who gets a new piece of gear is tempted to plug it in and see if it will play. If the equipment is old or has been used extensively you may be running the risk of burning out the power transformer or rectifier because of an electrical fault. I usually choose to avoid the risk just mentioned by using a different procedure. With all of the tubes out of the set I turn on the power switch and check the line cord with an ohmmeter to see if it shows an amount of resistance that is normal for a transformer primary winding. You may find a shorted line cord or an open line switch this way. Many communication receivers are equipped with line-to-chassis bypass capacitors. I never trust them very far since you can get a nasty shock from the chassis if one of them is defective; check them with the ohmmeter, too. If the items listed above are all okay, turn on the power. Pilot lights should operate at full brillance and the transformer should run cool and quiet. If it continues for ten or fifteen minutes you can assume that there are no shorted turns in the transformer or shorts in the filament wiring. My set passed this test so I shut off the power and plugged in the rectifier tube and turned the power on again. In a few seconds I heard an ominous growl from the transformer and I got a distinct odor from the set. I cut the power immediately. After turning the set upside down so that I could see the components I again applied power for about ten seconds. The transformer noise resumed and a wisp of smoke came from a well-cooked resistor that my first inspection had overlooked. Under it was a moulded paper bypass capacitor of the type commonly used in equipment of World War II vintage. It had a suspicious-looking bulge on one side. Tests with the ohmmeter confirmed that the capacitor was shorted and that the resistor had dropped radically in value. Finding a definite cause of trouble like this is encouraging; you may have discovered why the set was taken out of service. Presumably fixing this case of trouble should restore the set to operating condition.

By good fortune I had been able to obtain an instruction manual for the set and so had no trouble identifying the faulty components. My faithful old junkbox yielded replacement parts of the proper kinds and values. I made the repairs indicated and tried the smoke test again. All was quiet so I



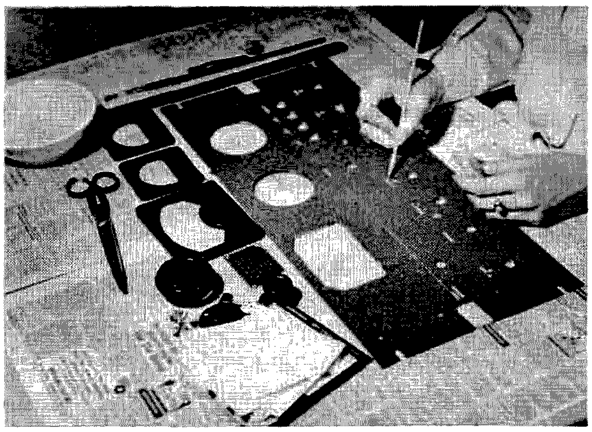
A length of thread helps to get the decals on in a straight line.

checked the B+ circuit with the voltmeter; I found the voltages above the values listed in the manual. That seemed normal, of course, since removing the tubes from the set would also remove most of the load from the plate voltage supply.

My next step was to check the contacts of all of the toggle switches with an ohmmeter (power off, naturally). As is often the case I found one with a nice crisp snap but it showed appreciable resistance in one position. It was replaced. I also recommend cleaning and lubricating the contacts on rotary wafer switches and the fingers that make sliding contact with the tuning capacitor sections. To do this I use a cotton swab that is saturated with silver cleaning solution—the "dip" kind, *not* the abrasive kind. About ten seconds of contact with the chemical is enough to reduce the black silver sulphide on a plated contact and leave it as bright as new. Other silver plated parts such as coaxial connectors respond well to this cleaning method. Don't be alarmed if you notice a hydrogen sulphide odor when using the chemical. Wafer switches tend to develop more sulphide on the end position contacts where wiping action is at a minimum and so these contacts should be given greater care than the others.

After the switch contacts have been cleaned I spray them with a combination of cleaner and lubricant. The lubricant in such sprays is a silicone compound that should not affect set performance in the hf and vhf bands. The propellant is usually a flurocarbon which is a highly volatile solvent. When using it you may want to put a piece of cloth under the part being sprayed. The cloth will catch the dirt that washes off of the part so that it won't muck up the chassis or other parts. It is best to buy a spray can that comes equipped with a long plastic tube to help you get the spray into places that are hard to reach.

When you are confident that you have done all that you can to put the set in good working order it is time to put in the tubes. If you have a tube tester, be sure to use it. If you don't have one I recommend that you buy new tubes for the *rf* and *if* stages. If you don't want to do that, at least reserve judgement on the quality of the set until you have put in the tubes that will give it a fighting chance to do a good job for you. Incidentally, be sure you are putting the right type of tube in each socket. The fact that you found a given type in a particular socket is no guarantee that it is the type that belongs there; it may have been put in as a temporary substitute; it may also have been selected at random and installed to give the set the appearance of being complete so as to add to its sales appeal.



Thinned lacquer is applied to the decals to give a "silk screened" appearance.

With tubes in the set you can align the *rf* and *if* stages. If you have a copy of the service manual try to follow it as closely as possible. There is no need for me to describe receiver alignment procedures here. They are a routine part of receiver maintenance and are described in considerable detail elsewhere.

Restoring the appearance

When you have spent a lot of time and effort building or restoring radio equipment you want it to look good. Suprisingly enough, many hams have failed to discover some of the tricks that are essential to giving the commercial look to their homebrew. The use of some of these methods will not only increase your pride in your work and your pleasure in using your equipment but it can add materially to its resale value.

A dull-looking wrinkle finished cabinet can often be improved. After scrubbing and drying it thoroughly fill in any scratches with matching paint. A draftsman's ruling pen may be useful with narrow scratches that expose the underlying metal; a brush will have to be used on chipped or worn places. After the touch-up paint has dried thoroughly, give the whole surface a *very* light coat of clear, glossy lacquer. Spray cans are handy for this kind of work. Each surface should be sprayed from two opposite directions, allowing time for each coat to dry. Care

must be exercised not to apply too thick a coat as that will fill in the valleys in the wrinkle finish and spoil the effect. Any new labels or decals that are needed should be put on before the lacquer is applied. While the finish on the case is drying you can turn your attention to some of the other parts.

Nameplates can be rejuvinated by filling etched areas with black lacquer or india ink; after it has dried it can be sprayed with clear lacquer or with a clear, semi-gloss finish that is used to protect paintings and watercolors. This particular kind of spray finish is available at art supply and paint stores. I prefer to use it in a situation like this as it does not contain any lacquer solvent and so will be quite compatible with the coating under it.

Knobs should be polished with a soft cloth and any missing setscrews replaced. If a line, dot or an arrow has been molded into the knob it can be renewed by filling the reference mark with white lacquer or with one of the white decorative caulking compounds that are sold for use around plumbing fixtures. They are available at many hardware and variety stores. The kinds that are water soluble until dry are especially easy to work with.

Your set may need the replacement of a specially-made knob, dial or decorative device that is available only from the manufacturer. If the set was made for the commerical market (rather than for sale to the military) you will usually find that the manufacturer or his authorized repair agency can supply the parts at a reasonable cost. Use of the correct replacement part is usually well worth the expense as it helps to preserve the resale value of the set. Orders for components should be addressed to the "Service Parts Department" at the manufacturers main address; the model number and serial number of the set should be given as well as a brief description of the part or its function. This information will help the factory to handle your order promptly.

The new panel

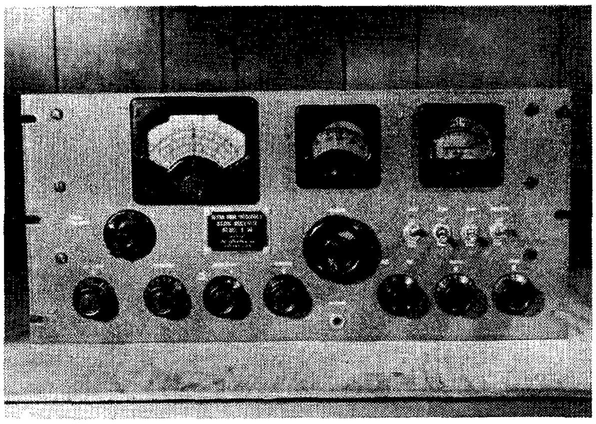
Producing a new panel is a real challenge to a true homebrew artist. It may be for use on equipment of original design or it may be for replacement on commercially-made gear. In either case you are constrained somewhat in that the location of some controls are fixed by the design of the device and its chassis layout. On the other hand, there will be some controls, switches or meters that can be placed in a way that will give the panel a balanced appearance. You may also recognize an opportunity to employ functional grouping of the controls for operating convenience. For example, the S-36 was originally designed with the avc, anl and bfo toggle switches located along the bottom of the panel. When planning the new panel I chose to place them under the "S" meter with the send-receive switch.

When you are laying out the locations for the various holes in the panel remember the old carpenter's adage, "Measure twice and cut once"; it's good advice. If you are replacing a damaged panel use the old one as a guide. If you are starting from scratch then make all of the measurements from two references such as a vertical centerline and either the bottom edge of the panel or a horizontal line on the panel that will correspond to the location of the top surface of the chassis. Remember to let the panel extend below the bottom of the chassis by an amount at least equal to the thickness of the bottom plate (if one is to be used) and the heads of the screws that hold it in place.

I usually prefer to use prefinished aluminum panels because they are easy to cut or drill. I selected a steel panel for use on the S-36, however, so as to avoid the possibility of corrosion between dissimilar metals.

Incidentally, panel colors differ slightly between different suppliers and over periods of time. If you want prefinished panels to match each other exactly, buy them at the same time and get them all of the same brand.

To begin work on the panel, locate and mark the centers of all of the holes that are to be made in the panel. Outline any large ones that are to be cut for dials or meters. It is often convenient to draw these on the heavy paper in which the panels are wrapped at the factory. Any kind will do, of course. After all of the holes have been located make a note of the diameter that each hole should be when the panel is finished. At this point you have an opportunity to place all of the knobs, meter, dial trim, etc. on the panel to get an idea of what the final appearance will be. When you are satisfied with the position of those controls whose location is optional you can then begin to cut metal. *Recheck all of your measurements.* Centerpunch each hole that is to be made and then drill a pilot hole of about 1/16" diam-



With a new panel the set even seems to sound better.

eter. Small pilot holes can be accurately positioned and they will make the cutting of larger holes much easier. Drilling the pilot hole also transfers all of the hole locations to the back of the panel so that you can work on it from the rear; then if a tool should slip and scratch the surface it won't show when the job is done. Try to keep the front side of the panel away from you especially when doing such manual operations as filing the edges of a rectangular hole. You may want to protect the front of the panel by covering it with a cloth or paper during some operations; if that is done, don't let the chips or shaving accumulate between the panel and the cover as they will scratch the finish.

When all of the holes have been drilled and the burrs removed, you are ready to apply the designations. I recommend the use of decals on a panel because when they are properly applied they most closely resemble the silk-screen process lettering used by manufacturers. Lay the panel on a flat surface that you can sit at comfortabiy. If you use the family card table remember to cover it with a newspaper. Have at least one of each size or style of the knobs, dials and nameplates at hand. Lay them in place on the panel so that you can decide exactly where the decals will look best. A piece of thread fastened to the panel at each end with masking tape will help you to get all of the labels level and in line with each other. Follow the marker's instructions in applying the decals. A wet decal is fragile but it can be moved around a great deal with a wet artist's brush. An art brush is stiffer than a camel's hair brush and is easier to use. When the decal is in place press it lightly with a dry cloth or a blotter. That will force some of the water out from under

the decal and cause it to stay in place. Let the decals dry thoroughly.

The next step is important to give the panel a commercially-built appearance. Decals made for use on radio equipment rely on a thin film of clear lacquer to support the individual letters or dial markings. When the decal is dry, light reflecting from the lacquer makes this backing objectionably obvious. With a little care you can dissolve the film without disturbing the letters. When that is done the letters will appear to be printed directly on the panel. To do this, mix one part clear lacquer with two parts of lacquer thinner. A thimblefull is all you will need. With a very small brush or a wooden dowel that has been pointed in a pencil sharpener apply some of the thinned lacquer to the bottom edge of the decal. Put it on *very* sparingly; let the fluid be carried under the decal by capillary action. Too much of the mixture will cause the letters to soften; too little will fail to dissolve the decal backing. You apply the solvent only to one half—the top or bottom—of a designation; the untreated half will hold everything in place while the solvent dries. Let it dry completely before you attempt to do the second half. The pointed dowel will be handy for treating the center of such characters as "O" or "G" as a final touch-up. You may have a teenage daughter or sister around the house. Girls are especially dexterous and can do this sort of job very well if you can get them away from the telephone long enough.

Before assembling the panel to the receiver I had one last job to do. The original panel had a circular cutout almost 6" in diameter over the main tuning dial. It was covered with a thin metal stamping. I had decided earlier that I could not cut a six-inch hole cleanly enough and I certainly couldn't reproduce the stamping. I had decided to provide a smaller opening and cover it with a dial escutcheon that I had left over from previous repair activity. The bakelite trim was supplied without any window material in the opining. I used a piece of 1/16" clear acrylic plastic for the window after cutting it to fit. I scribed a vertical line in the middle of the plastic and filled it with india ink; the line serves as an index for the dial. Some designations were added to the plastic and it was fixed in place by means of a drop of cement in each corner.

With all of the preliminaries out of the

way one is ready for the final assembly. Dial trim, nameplate and the meter were fastened to the panel; the meter and pilot lights were connected. Sometimes these connections can be made more easily if you can move the panel around a little bit so I completed those steps before I fastened the panel to the side braces and chassis. Finally I put on the knobs and the set looked the way you see it pictured.

Except for some trimming of the *rf* stages to put the dial calibrations on the nose, that is the story. Four basic operations were involved: cleanup, trouble shooting, repair and refinishing. A lot of work? Usually; that will depend on the set. But if you follow the routine outlined above your chances for success are excellent. Furthermore, as a reward for your efforts you will gain both valuable experience and the pleasure of having another fine instrument in your shack. Good hunting! . . . W9NLT

Correction

In the article "Mighty Four on Six" in the November 1967 issue, the coil data was inadvertantly left out of the schematic. With due apologies, we now print this information.

L_1 is 8½ turns of #22 enamel wound on a 5/32" slug tuned plastic form. The tap is at 3¾ turns from the cold end.

L_2 is 3 turns of #22 enamel wound around the cold end of L_1.

L_3 is 5 turns of #16 air wound with a 5/16" inside diameter.

RFC_1 and RFC_2 are approximately 6.8 microhenries. (A Z-50 or 20 turns of #30 enamel wound on a ¼" powered iron slug.)

R_6 is the 100 ohm resistor supplying −V to the modulator.

R_5 is the 10 ohm resistor connected to RFC_1.

The crystal is a third overtone—50 MHz.

SB-33 Note

Some distortion has been noticed when the SB-33 is used with some linear amplifiers. This is usually due to rf feedback and can easily be cured by inserting an rf choke in the 10 volt line and bypassing it. This is pin 7 on J1. Insert the rf choke (1-2.5 mh) and bypass with a .001 mfd 200v ceramic to ground on the end of the choke away from pin 7. Use short leads. . . . K6SHA

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New Life for an Old Work-Horse

A quick look at the advertisements appearing in the amateur magazines show an old work-horse receiver, this receiver sells for between $150 and $200 used. What is it? The Collins 75A1, that's what. This receiver, although designed in 1947, is still superior to many receivers being made today. The calibration, selectivity, and stability can only be equalled by other Collins receivers. Even though this receiver was designed before side-band was popular, it still does a remarkable job receiving SSB as well as RTTY, CW, and AM. However, there is still something to be desired in the 75A1. This is obvious, for if the receiver were perfect, Mr. Collins would not have authorized the newer receivers (75A2, A3, A4, etc.). These problems may be corrected easily and without great expense.

The problems? Well, the audio quality can be improved. Also, the design of the input circuit (antenna) is such that it does not match coax on any band. The input impedance is about 200 ohms on 80 meters and keeps going up until an impedance of 1500 ohms or greater is reached at 10 meters. Third, the bfo circuit is fine for CW with 1 kHz either side of frequency. However, RTTY and SSB need about 3 kHz.

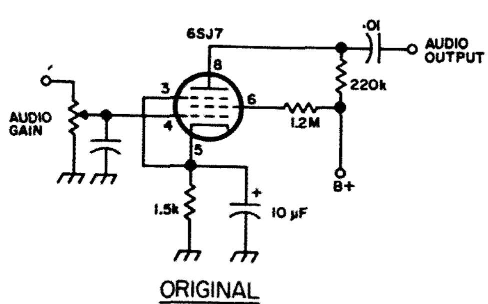

Fig. 1. The Original circuit for the first audio stage of the 75A1 receiver.

Each of these problems are easy to correct. The audio quality may be improved greatly by rebuilding the first audio stage; the input circuit may be easily modified; and the bfo may be expanded by the addition of one component. How to do this? Read on.

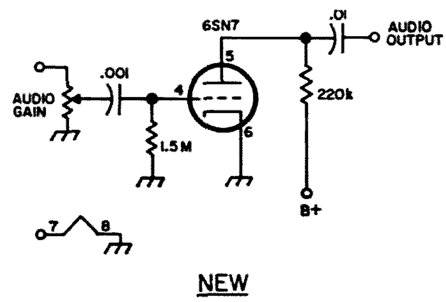

Fig. 2. Modification to the first audio stage, using 6SN7.

The existing first audio stage in the 75A1 is a 6SJ7 noted as VII on the schematic. This stage is capable of high gain, but severe distortion often takes place on voice peaks. This may be corrected by the simple rewiring of the socket to accept a 6SN7. A total of one capacitor and one resistor are needed to complete the operation. **Fig. 1, and 2,** give the original circuitry and the new circuitry. Also, the audio output stage may be modified with the addition of a cathode by-pass capacitor and a tone control (Fig. 3). The tone control is a great help on CW and Voice. However, the reduced bandpass does not allow the RTTY tones to pass sufficiently. Thus, I did not add the tone control to the K9STH 75A1. However, the circuitry was tested and it worked very well.

The antenna input circuitry may be easily modified to accept coax. The modification consists of removing the twisted pair going to the existing antenna input coil. A new coil is wound over the grid coil. This new coil consists of three turns of number 22 wire close wound at the end of the coil nearest the chassis. Then the remaining wire is twisted and connected to the antenna input terminals on the receiver. If desired, a coax connector may be installed on the rear of the chassis and the twisted pair connected to it. This operation takes about fifteen minutes and is well worth the trouble, for the input impedance is reduced to a value which will easily accept coax-fed an-

tennas. This idea is not new, but it has been a long time since I have seen anything on it.[1]

The third trouble spot may be eliminated by replacing the tuning capacitor with a capacitor of similar size but with approximately three times the capacity. The capacitor in the K9STH receiver was similar to the surplus APC variety. This capacitor had four rotor plates. This was replaced by a similar capacitor from which all but thirteen rotor and stator plates had been removed. The replacement capacitor came from a BC-610 tuning assembly and had an original maximum capacity of 100 pF. However, many of these capacitors may be found in other places. Even other types of capacitors may be used, but one of the same physical dimensions as the original makes things much simpler. Just in case there are other types of capacitors used than in the K9STH receiver, it would be advantageous to examine the existing bfo variable. A rule of thumb is to multiply the number of existing plates by three and add one for good measure. The capacitor added to the K9STH receiver gave three kHz either side of center when the indicator mark on the knob was at the old 1 kHz marks.

After the modifications are complete it would be advisable to completely realign the receiver. If the original manual is available, follow the instructions in it. For the benefit of those amateurs who do not have access to a 75A1 manual, a brief alignment procedure follows:

Low *if*

1. Turn on the receiver.
2. Connect a 500 kHz signal to the grid cap of the 6L7 noted V4.
3. Place the selectivity control in position 4.
4. Tune the signal generator for maximum "S" meter reading.
5. Place the selectivity control back in the "0" position.
6. Align the *if* cans for maximum reading on "S" meter.

High *if*

1. Place the receiver bandswitch on 80 meters with avc on.
2. Inject a signal at 2.5 MHz into the grid of the 6SA7 noted V2 (pin 5).
3. Tune the receiver to approximately 3.2 MHz on the dial. Peak the signal on the "S" meter with the tuning dial.
4. Tune the trimmer capacitors in the section of the chassis marked "*if* 2.5 to 1.5" for maximum "S" meter reading.
5. Change the input signal to 1.5 MHz and tune the receiver to 4.2 MHz. Peak the signal on the "S" meter using the main tuning dial.
6. Tune the slug-tuned coils on the traverse bar in the section marked "*if* 2.5 to 1.5" for maximum reading on the "S" meter.
7. Repeat steps 1-6 several time.
8. Switch to the ten meter band.
9. Inject a 5.5 MHz signal as in step 2.
10. Tune the main tuning dial to 28.0 MHz, peaking the signal on the "S" meter.
11. Tune the capacitors in the section marked "*if* 5.5 to 3.5" for maximum "S" meter reading.
12. Tune the receiver to 30.0 MHz.
13. Inject a 3.5 MHz signal as in step 2.
14. Peak the slug-tuned coils in the section marked "*if* 5.5 to 3.5" for maximum "S" meter reading.
15. Repeat steps 9-14 several times.

Note: The above adjustments may be made with input at the normal received rf frequency. Use an 80 meter signal for the low and first high *if* alignments. A 10 meter signal may be used for the second high *if* alignments. However, use a signal generator if available.

Wiring Changes

In changing the new 6SN7 for the old 6SJ7 connect 6SJ7 pins 4 to 6SN7 4, 7 to 7, 8 to 5, and ground 6SN7 pins 6 and 8. The rest are unused.

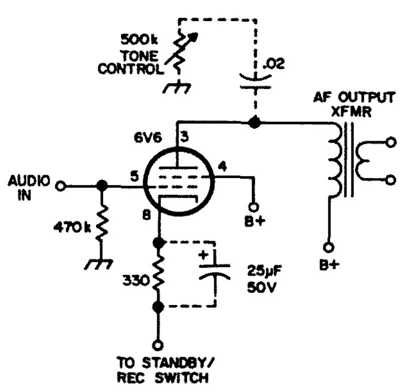

Fig. 3. Audio output modifications.

1. Second Guessing the Experts, by W. I. Orr, *CQ* magazine September, 1951, p. 21.

RF Adjustments

Tune the receiver to the high end of the respective amateur band and adjust the capacitors in the Antenna and rf portions marked on the chassis. Then tune to the low end of the band and tune the slug tuned coils in the same section. Each time peak for maximum "S" meter reading and repeat several times for each band to obtain optimum performance. The proper adjustments for each band are plainly marked on the 75A1 chassis. Tune the bands in the following order: 80, 40, 20, 15, 10, 11.

The frequency may be checked with WWV at 15 MHz. By use of a 100 kHz crystal calibrator, the calibration of the other bands may be checked. The proper adjustment for each band is plainly marked on the chassis.

After completion of alignment the receiver is ready for use. A quick tune across the amateur bands will show why Collins receivers have become the most desired of units. The 75A1 is superb for regular amateur work, and, with the addition of converters, is an excellent VHF receiver. By using 11 and 10 meters for the tunable *if*, complete coverage of the 6 and 2 meter amateur bands is available. Also, the low noise figure of the receiver makes it an excellent tunable *if*. Thus, it is impossible to lose with the 75A1.

So, unless you have another Collins receiver, run to your neighborhood amateur supply store and beg, borrow, or even buy (!) a 75A1 and get to work and give that old work-horse new life.

. . . K9STH/5

D. E. Hausman VE3BUE

Stop Those Slipping Knobs!

Radio knobs have the annoying habit of loosening to the extent that they slip. This looseness can be corrected by tightening the set-screw, but after some time the control shaft which is turned by the knob becomes scored with marks from the set-screw. Retightening the set-screw leads to more problems as the knob will likely crack. An easy way to solve this predicament is to slip a piece of fine sandpaper—grit side on the control shaft—between the inside of the knob and the circumference of the shaft. The sandpaper grips the shaft tightly and prevents the knob from cracking.

1968 HAMFEST AT 73

Come on up July 6th and visit New Hampshire

Ever since our last hamfest, in 1965, everyone has been after us to have a repeat performance. The editorial in February explained some of the reasons for the delay.

This year we are going to do it again. July 4th comes on Thursday this year, so we will schedule our Hamfest for Saturday, July 6th. We'll try to have lots of entertainment for you on Saturday. We'll have more details on this later, but it looks as if the VHF gang will have a chance to bring their 144 and 432 MHz antennas for a measuring contest run by Leger Laboratories. I expect that André of Vanguard will be up here with all of his latest products; plus many other 73 advertisers.

We'll organize an auction of gear, so bring stuff you want to sell and lot's of money to grab the bargains. Last time thousands of dollars worth of gear changed hands and I'm afraid the buyers got some incredible bargains.

Saturday evening I will show some of the slides of my DXpedition to those interested in seeing some pictures of weird places.

Early Sunday morning we will form a caravan heading north into the White Mountains, about 100 miles away. There we will visit some of the tourist attractions that have made New Hampshire the most visited tourist state in the East. We will see the famous Old Stone Face, the great New Hampshire Man of the Mountains. We'll see and walk up through the Flume. We'll take the tramway to the top of Canon Mountain for one of the panoramas of a lifetime. We'll see the beautiful Old Man's Foot Basin. We'll stop off at Clark's Trading Post and see and hear some of the old time music boxes and see the trained bears. We'll visit the historic Morse Museum and, if we can work it in, climb through the caverns of Lost River.

New York is just a little over 300 miles of turnpike driving away, so those that have to get back can make it Sunday evening. For the rest we can drive or take the cog railway to the top of Mount Washington on Monday morning. The more athletic can start from the cog railway station at the base and climb the mountain.

This will be an outing that the whole family will enjoy. There are many beautiful picnic spots near Peterborough and we show them on a special map that we have printed of the Monadnock region of New Hampshire. You can get one of these maps when you arrive or send us a SASE and we will send you one right away. This map also shows points of interest in this area, restaurants, etc.

Mobileers will want to try their luck from the top of Pack Monadnock, just 3.5 miles east of the 73 headquarters. You can drive right to the top of this mountain and get a straight shot right into Boston and down to New York.

At any rate, if you can get away for a couple of days or so, why not join us up here at 73 for a couple of days of fun and sightseeing around New Hampshire?

. . . W2NSD/1

Del Crowell K6RIL
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Modification of the TRA-19 Amplifier Cavity to 432 MHz

In the past several years this amplifier has been showing up quite consistently on the surplus and Mars outlets. The cavity was used in conjunction with a wide band FM field telephone system, the driver section used an FM oscillator plus multiplier stages using two 829B tubes covering 230 to 250 MHz. The driver is not too popular, but the 4X150 power amplifier makes a very nice 220 MHz final for CW-AM or SSB use. The amplifier was used as a separate unit complete with its inter-connecting power supply, many of the units are available without this power supply which delivered 830 volts at 250 mA. As most hams agree, this supply is not too important and much higher B+ voltage is generally used. This conversion covers the modifications of the cavity to use it on 432 MHz.

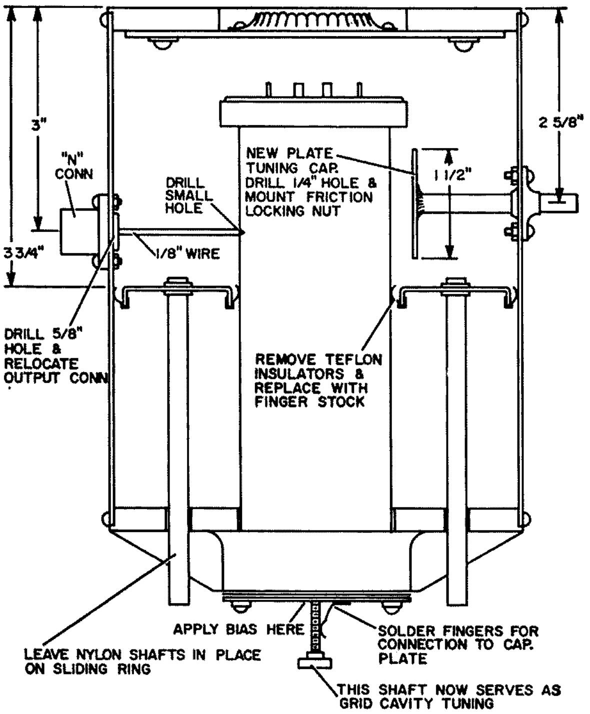

Fig. 1. Detail drawing showing plate cavity modifications.

Disassembly and conversion

Be sure to mark all mating sections before taking apart, this helps as the parts are again assembled after the modification. After the cavity is completely disassembled, drill the new holes as shown in **Fig. 1.** Relocate the output connector, using a larger wire for the coupling loop, and drill a small indent in the inter line as shown. The plate tuning capacitor is assembled from a ¼-28 thread shaft and a 1½ inch disc. The disc is soldered to the shaft and a little care must be used to get the shaft centered in the disc. Two metal friction plate nuts, such as used in aircraft work, were fastened to the cavity wall. This provides a good rf contact and also serves as a friction lock. The nut is very tight at first, so it is best to use a short bolt or tap to open the threads a bit so the capacitor shaft will turn smoothly.

In original operation the plate tuning was done by a sliding ring with Teflon insulators. This ring was simply a movable capacitor. To change the cavity frequency, this ring is converted to a shorting device which is a new bottom for the cavity. Once in position the tuning is done by the new capacitor previously described. Leave the nylon rods in place to help in positioning the ring. The tube plate collet is modified for high voltage by cutting down the outside diameter. This provides the necessary spacing to prevent arcing at 2500 volts. It is recommended that 4CX250 type tubes be used if this high voltage is used.

Grid cavity

When this cavity was designed the designer really did us a favor. Simply remove the bakelite tuning slug and the spacer at the end of the line. This cavity now will tune thru 432 MHz. The coupling wire is bent and soldered to the line as shown in **Fig. 2.** The large spacer can be removed by

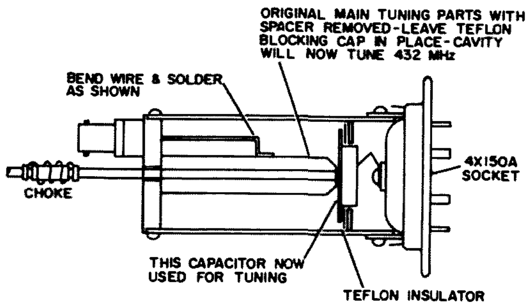

Fig. 2. Grid cavity modifications. The original main tuning parts are removed.

heating with a torch or a very large soldering iron. Soft solder was used in the assembly and the cavity is again assembled as it came apart.

Final assembly and operation

The complete cavity can now be assembled using the marks to position the sections. A spring finger should be soldered to the capacitor plate at the end of the main cavity. This finger makes a constant electrical connection to the capacitor plate (the rod used for grid tuning also is a bias connection).

The main iron frame in which this cavity was originally mounted can still be used; however, the original tuning mechanism will no longer be usable. The cavity also can be mounted on a new chassis along with the driver stages. However, at this station two identical cavities were modified and mounted on a common chassis. These cavities were connected to form a 1 kw amplifier by using ¼ wave phasing lines on input and output.

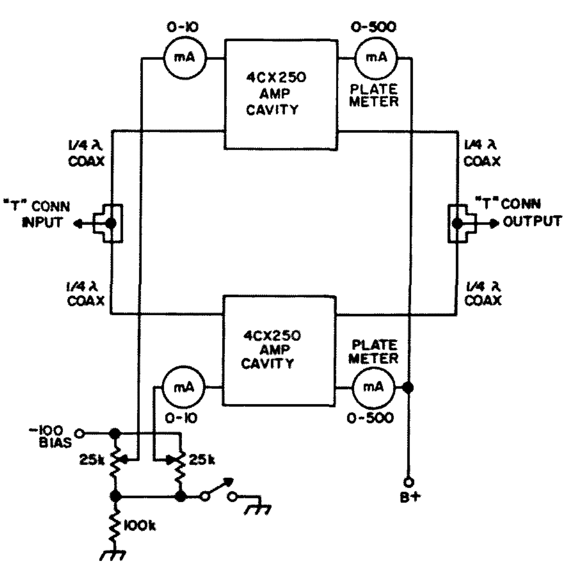

Fig. 3. Block diagram showing cavity connections.

Each cavity was tested individually before mounting on the amplifier chassis. The results were as follows: plate power 228 watts dc; grid current .5 mA; rf output 120 watts. The tubes used were 4CX250B's.

The completed amplifier (using both cavities) operated quite well. At first the filament voltage was too high, which resulted in excessive back heating and ruined a pair of tubes (let this be a lesson to all). The voltage was reduced, and the problem was solved. The system has tuning controls for each cavity, so each has to be adjusted for maximum power out and equal currents. The results were as follows: for CW operations at 1 kw input, the output was over 650 watts. This amplifier performed very well and was used to work KP4BPZ via moon-bounce.

A final comment: this method of phasing two identical cavities will work quite well at all bands. Home brew cavities such as in the VHF handbooks will work equally well. Refer to block diagram in **Fig. 3** for reference in connecting the cavities.

. . . K6RIL

Salvage Those Old Transistor Radios and Recorders

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This may be 'old stuff' to you old timers and you will 'turn up your nose at it, but think of the younger ones who have yet to learn all this! They have to be taught to scrounge, and the uses for what they get.

What good are the little cheap tape recorders, too cheap to go to the service shop for repairs? They are usually a three transistor amplifier in the cheapest units and better in the more costly ones. My wife and I usually investigate every noise at night that sounds strange, so I mounted a small three inch speaker in the garage and one at the rear basement window. I mounted the little three transistor amplifier, a six volt lantern battery, a SPDT toggle switch and the vol. control in a metal box. The switch throws either input line to the amplifier. I used a little transistor output transformer backwards to match the speakers and microphone to the input of the amplifier. I also mounted a jack connected to the output. I can use either a small speaker or phone. Now at the least noise, I can check each place with ease.

Using output transformers (scrounged from transistor radios) backwards (two of them, one for input and one for output) plus two switches and two speakers and either a battery or homebrew power supply, you have a nice intercom.

These amplifiers, mounted in a small case with battery and speaker (omit and use phone if desired), a 500 $\mu\mu$F capacitor, a resistor of about 3 to 5 k, a IN34 diode and a .001 by pass will make a fine rf/audio signal tracer. The input to the amplifier connects to a phone jack. One shielded wire with test probes at the other end is the audio probe. Be sure you have a paper input condenser of .25 to .5 μF instead of a electrotytic or you will find that the wrong polarity on the probe will kill the amplifier, resulting in no signal. For the rf, mount the diode (polarity doesn't make any difference) with a 500 $\mu\mu$F going to the probe and one end of IN34, and the .001 from the other side of the diode to the shield and, of course, the hot wire of the shielded cable going to the junction of the diode and .001 condenser. This can be mounted in some of the test probes designed for meters. Use mike cable as it is flexible. This will make a fine signal tracer.

The amplifiers can be used as an 'already made' audio system for your receivers. I keep one around to connect to various super regen and vhf receivers I test board up, that way I don't have to breadboard an audio system. Again be sure of polarity of the input capacitor if you use pnp and npn transistors in your receiver. If polarity is wrong, the amplifier won't work right.

Many more uses can be thought up as the need arrives, as they are handy when you can buy them from 25¢ to $2 at rummage and garage sales.

The radios? I have one unit on which I stripped the front end (loop, gang condenser and oscilator coil), and mounted an *if* transformer (be sure you complete the old mixer emitter circuit which probably went to the osc. coil.) Usually one *if* stage will have to be detuned as there is too much gain you could just as well remove the mixer/oscillator transistor and bring out the collector lead of the transformer to a test point. I used the above method but I think the latter method would be better as there is too much gain. I use this an an *if* audio system for converters (vhf of course). Now I will tell you the faults! Due to the low 455 Hz *if*, there are birdies. Tunable converters are not drift free I have found, and with a low *if* frequency it is worse. Still, I have this unit around as it comes in handy now and then.

Sets with a short wave band can be used as a tunable *if* for converters but I found that the autodyne mixer (one transistor for both mixer and osc.) is subject to too much oscillator pulling, so in one junk model, I used the mixer as an oscillator and added another transistor as a mixer with emitter injection of the oscillator signal. This type of receiver has enough *if* range, plus image

rejection due to high input frequency and is also 'double conversion' when used with a converter.

On receivers for the FM band, rewind the coils for six meter operation. Again I frown on autodyne mix/osc. I have not tried changing one to two meters but I would advise changing transistors—change the mixer, in any case, as it is probably working at it's highest frequency where it has gain, and on 2 the gain may be low so you will have to experiment.

You probably have seen in other magazines about converting the CB walkie/talkie's to 6 (I remember the article on a cheap three transistor unit). The only help I can give may be worth it to some of you. I had a pair and even on CB the modulation was low. With one at each end of the basement I could not get enough audio to set up an audio howl. I mounted two small output transformers backwards in hookup to match the speaker vc to transistor input when the switch was in transmit position and the speaker was then a mike I had to solder them to the speaker frame as there wasn't room anywhere else if I wanted them inside the case. Anyway, with a better match from the 'mike' (in transit position) I now had enough modulation to set up a good audio howl. Use this idea on CB or 6 meters

. . . KØVQY

Correction

Two rather serious errors have been found in the circuit for the NBFM article in March 73.

In **Fig. 6**, page 9, the collector resistor from the 8.2 battery terminal should read 100 K, *not* 1 MEG as it appeared.

In **Fig. 7**, page 10 (the vacuum tube version of **Fig. 6.**) a 200 K resistor was omitted from the diagram. To correct this error, omit the line from the plus 250 terminal to the 5.1 K resistor as shown and insert a 220,000 ohm 1 watt resistor from the 250 volt terminal to the junction of the 1 Meg. resistor, the 25 mF 25 volt capacitor and the 5.1 K resistor. Approximately 6 volt positive voltage will be found at this junction, depending upon the resistance tolerances of the divider. This is the bias voltage for the voltage variable capacitor V15E or 6.8SC20.

Labels for Homebrew Gear

Using your typewriter to make neat labels.

Jack Grimes W4LLR
Box 16004
Memphis, Tenn. 38116

How many times have you bought a pre-finished panel to be used on that pet building project, then exercised all the care of a skilled engineer to make the layout and wiring plus-perfect, only to end up with that home brew look. Usually because you could not find the decal you needed.

Perhaps you settled for leaving the panel blank; resorted to one of the tape-label-printers, or maybe even engraved (polite for scratched) the information you considered absolutely essential onto the surface.

It was the completion of a T U and the absence of any RTTY decals at the local distributors which sparked this idea.

The best source of print available to the average ham, or other home project builder, is the typewriter. But it seems somewhat ridiculous to mention sticking a box, cabinet, or ⅛ inch panel in a typewriter. Typing on a piece of paper and scotch-taping the paper onto the equipment hardly produces a commercial look.

The new invisible Scotch Tape looked promising. This is the type which looks cloudy until pressed in place. The 3M Company advertises: "You can write on it."

Why not type on it?

So a small piece was stuck on the typewriter platten and keys pounded.

The result looked good, but alas, when the tape was pulled from the roller and rubbed onto the panel, the printing smeared and came off. The printing needed to be under the tape.

The logical thing to do about this time was forget the whole thing, since if you type on the bottom of the sticky stuff the printing would be reversed.

But the old do-or-die-spirit refused to give up. After deep thought, many sleepless nights, and a good friend pointing out the obvious, the brilliant inspiration came.

Why not transfer the letters from the top of one piece to the bottom of another piece of the Scotch Invisible Magic Tape.

Tape went on the platten, sticky side down, Peck out the words:"Jack Grimes, AF4LLR, Memphis, Tenn."

Then another piece of tape right over the top while the first piece was still on the platten.

Would the tapes separate?

They did easily, The nice commercial print lifted from the top non-sticky side of the first piece of tape and came off on the bottom, sticky side of the second piece.

Quick! Press it down on the nearest grey crackel finish. The front of the typewriter. (Who could wait to hunt up an old panel?)

The invisible tape practically disappeared, but standing out sharp and clear, on the typewriter, was the professional look every home constructor would like to achieve.

Surely anyone would have been satisfied to quit at this point. But one problem remained. The black type looked plenty sharp on grey panels, but it was worse than useless on a black panel.

Red or Blue ribbons were almost as bad, and you can produce some mighty peculiar expressions on a clerk's face when you go in an office supply store and ask if they have a white typewriter ribbon in stock.

However all the stores do carry some little white sheets, or ribbons of white carbon, which are used to stick behind the typewriter ribbon and "type-out" errors.

This gimmick did the trick.

Hold the white paper behind the ribbon. Keep moving it a slight amount so you get nice clean print on the invisible scotch tape. You may need to back-space and print the same letter more than once. Transfer the print to the bottom of another piece of tape. Trim the finished label to size and press firmly on your latest creation.

Or you may wish to affix identifying labels to brief cases, musical instrument cases. etc. The results will amaze you, and won't fracture your pocketbook.

. . . W4LLR

William L. Smith, W3GKP
1525 Spencerville Rr.
Spencerville, Md. 20868

Counter Connections

Regardless of whether you got it from MARS, found it in the junk yard, built it from scratch or paid money for it—if you're fooling with a frequency counter you should find an idea or two here.

So you've got a counter working. Now what?

The first thing you'd better do is find out what the counter will do. The most important things you need to know are the frequency range, the input sensitivity, and the accuracy.

If you have an ex-commercial or military unit the chances are that all this info is set out in the specs or instructions. Most of these types, even the oldest, will count up to 100 kHz. If the front end tubes are in good shape and everything adjusted properly don't be surprised to find that it works okay up to 20 percent or so above the rated top frequency.

If you don't have the specs, or if you have a home-brew counter, you will have to measure the performance yourself. To start out, a hook-up something like Fig. 1 is called for. Starting at a low frequency, say about 1000 Hz, vary the output up and down until you know what signal level is required to make the counter indicate properly. Then, maintaining the output at about twice this level, slowly increase the frequency by tuning the oscillator upward while observing the counter indications. If it is necessary to change bands on the oscillator or signal generator repeat the "output level" adjustment to make sure you are above the minimum voltage required for counting. You may find that the signal level needed increases gradually as you tune upwards.

Sooner or later you will reach a frequency where the counter either fails to indicate at all, or indicates lower as you tune higher. Increase the oscillator output in an attempt to make the unit keep counting. Lower the frequency if necessary to make the counter indicate correctly. By now you know with reasonable accuracy the limits of voltage and frequency for normal counting. You should keep these limitations in mind when designing accessory circuits for your counter.

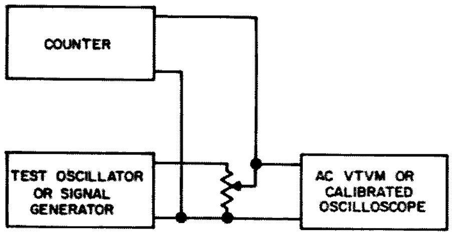


Fig. 1. Measuring the sensitivity and frequency range of a counter.

This is not the place for a long dissertation on oscillator stability, but I think it should be obvious that every counter contains or uses some sort of a frequency standard, and the counter indications are no more accurate than the standard. For example, many older counters use a 100 kHz crystal oscillator operated without an oven and trimmed to "exact" frequency by a big mica compression trimmer capacitor. Such a unit can be no more accurate than the oscillator (which will never put WWV out of business) and its indications will probably be affected by temperature and humidity. Simpler units may use the power line as a frequency standard, and these will be even worse. It has been a few years since I measured the local line frequency on good apparatus. At that time it was fairly common to find it off a few hundredths of a hertz, but I never found it off as much as one-tenth of a hertz. In other words the instability was a little under one part in 1,000.

Another factor which affects accuracy is the fact that the counter can't split a count. This applies chiefly at low frequencies where the number of digits indicated is low. For example, if the counter reads "50" (fifty hertz or fifty millihertz or fifty anything) the true value might be off by as much as one digit, that is, it might be 49 or 51, so the error might be as much as 2 percent. The solution in a case like this it to make the measurement repeatedly and to average the results.

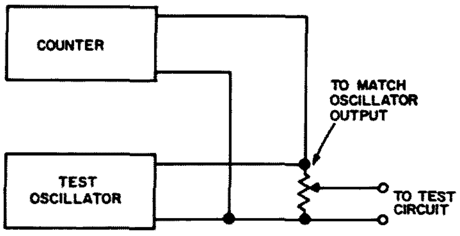


Fig. 2. The counter as a precision dial.

For many jobs you will be using the counter as an accessory for some other piece of test equipment, to enhance its utility or improve its accuracy. An example is shown in **Fig. 2**, where the counter serves as a precision dial for the test oscillator. The use of an external attenuator or "volume control" allows the oscillator to be run at a high output level (to provide a big signal for the counter) while the level to the circuit under test is adjusted to suit whatever conditions prevail.

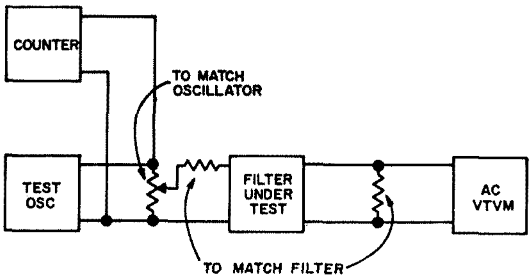


Fig. 3. Measuring filter response.

Fig. 3 shows the use of this circuit in testing a filter for frequency response. In doing a job like this without a counter it is usual for the operator to set the oscillator to some "even" number of hertz or kilohertz, etc., and read the output level. When a counter is used it is much more convenient to do it the other way. Simply tune the oscillator to a point of peak response, or a null, or to any point of interest on the curve, and read the frequency from the counter. This procedure gives improved accuracy and avoids the possibility of missing any little bumps or valleys in the response curve. **Fig. 4** shows the response of a pair of audio filters built for low-shift RTTY.

If the counter and the oscillator operate at receiver intermediate frequencies the same procedure can be used for testing mechanical filters. A suitable test circuit is shown in **Fig. 5.** The main difference between this and the preceding figure is the provision of the two variable resonating capacitors, which are needed to tune the input and output coils of the mechanical filter. **Fig. 6** is the response curve of a mechanical filter taken with this circuit.

In lining up tuned circuits for use in L-C filters the circuit of **Fig. 7** is useful. This is like **Fig. 2** except for the 1-ohm resistor, which guarantees a low and non-reactive source impedance for the circuit being tested. (Many readers will recognize this as the basic circuit of a Q-meter). While it is usual to use an available toroid or other high-Q coil and select a capacitor or group of capacitors to match, I have done it the other way; i.e. pick a capacitor and adjust the toroid by peeling turns until the desired resonant frequency is reached. For temporary filters or for experiments the quickest way is to use an available toroid, pick out a capacitor which is "close but not quite" on the high-frequency side of resonance, and then do the final trimming with a big compression-mica trimmer of the type made by Arco.

Once the components have been selected in the circuit of **Fig. 7** it is fairly easy to measure the "Q". After locating the frequency of peak response, detune the oscillator on one side of resonance until the VTVM (or scope) indication drops 3dB (i.e. to 7/10 of its peak value), and note

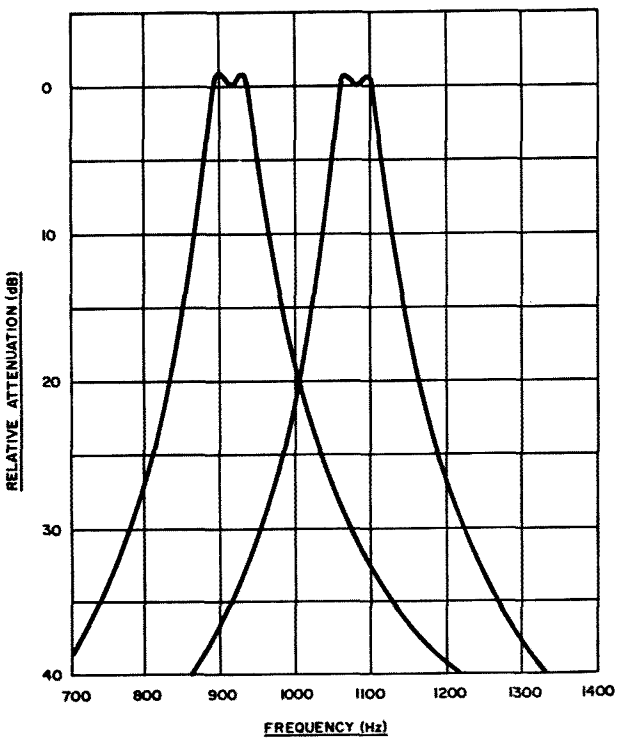


Fig. 4. The response of a pair of audio filters as measured with the circuit of Fig. 3.

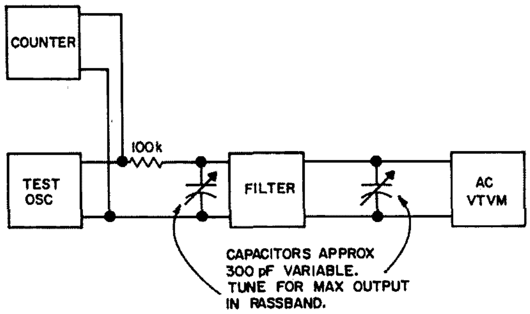


Fig. 5. Testing a mechanical filter.

the frequency. Do the same thing on the other side of resonance. The "Q" is equal to the resonant frequency divided by the difference between the two 3 dB frequencies. This is an essential check if there is any question at all about the quality or suitability of the components. Old paper capacitors which read fine when tested for dc leakage sometimes turn out to have low Q when checked by this method. Purists will note that the 1-ohm resistor degrades the circuit Q slightly, and are permitted to indulge in corrective mathematics.

With a few simple "standard" components the same circuit (**Fig.** 7) can be used to measure inductance and capacity over a considerable range. I have a 0.02 microfarad one percent capacitor and what I think is a "good" 100-millihenry toroid. After I peak the circuit with them I am ready to add other capacitors in parallel (or in place of), note the frequency change, and compute the value of the added component by the usual handbook formulas.

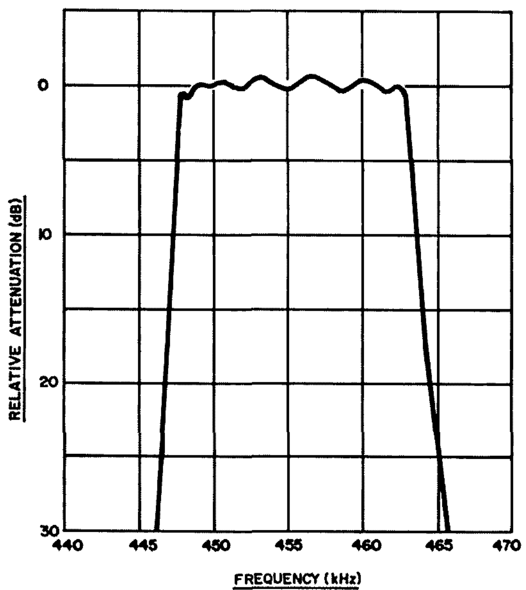


Fig. 6. Response of a wide-band mechanical filter measured as in Fig. 5.

Of course, other coils can be substituted, and unknowns of low impedance (low inductance or high capacitance) can be inserted in series rather than in parallel.

By now the rf enthusiasts may have wandered off to another page. I hope not, because it is about time to consider how to make precise HF and VHF measurements with a low-frequency counter.

It takes some more gear, and the first thing you need is a frequency standard, and possibly a divider chain. The one I use

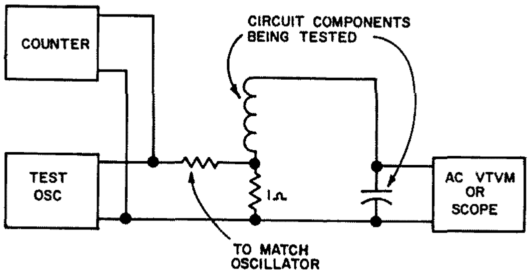


Fig. 7. Checking filter components.

is shown in block form in **Fig. 8.** Details of the circuit seem out of place here, as something suitable can be found in most any handbook. In my case the standard-frequency oscillator runs at I MHz and a divider chain is required to get the standard markers close enough to permit interpolation with a low-frequency counter. If your oscillator operates at 100 kHz or lower you may not need the dividers. If you have to build this from scratch it pays to consider transistors, as they eliminate most aging problems and make the power consumption so low you can let the whole works run continuously. My dividers are simple locked multivibrators; they work satisfactorily and have stayed locked for years without adjustment. My divider chain goes all the way down to 500 Hz, but the most-used output is at 50 kHz.

The output of the divider chain at 50 kHz drives a harmonic generator and modluated amplifier, as shown in **Fig. 9.** (A detailed schematic of this circuit was presented in QST for July 1967, page 92, by W4HHK.) This circuit produces markers at 50 kHz intervals up to several hundred MHz. For routine ham operation these tweets are loosely coupled to the receiver input and serve as a full time calibrator and bandedge marker. (Perhaps next year I will change to 25 kHz to mark the extra-class segments precisely!)

The output of the circuit discussed above

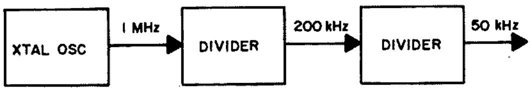


Fig. 8. Standard-frequency oscillator and divider chain.

may be visualized as shown in **Fig. 10.** Now if the modulated amplifier of **Fig. 9** is driven with the low-frequency oscillator of **Fig. 2,** each of the 50 kHz markers will grow a

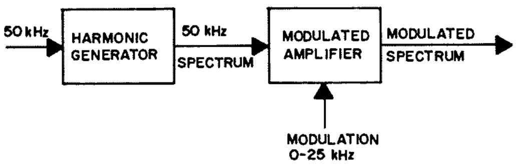


Fig. 9. Harmonic generator chassis.

pair of sidebands, as shown in **Fig. 11.** The separation of each sideband from its parent carrier is equal to the setting of the low-frequency oscillator.

Now we have a scheme for zero-beating any signal which turns up in the band.

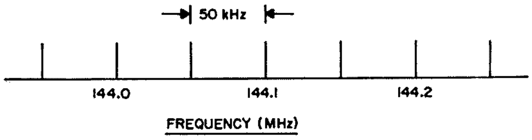


Fig. 10. Output of Fig. 9 without modulation.

For example, assume a signal appears at 144,161 kHz in the two-meter band. The nearest marker is at 144,150. From the receiver dial reading we can tell that the signal to be measured is about 10 hHz above this, or near 144,160. So we set the low-frequency oscillator near 10 kHz, turn up the output, and rock the oscillator tuning until we hear the sideband come close to

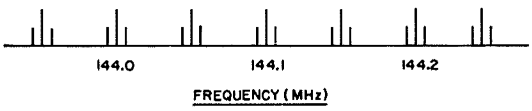


Fig. 11. Output of Fig. 9 with modulation.

the signal being measured. Now we can adjust the oscillator frequency very slowly and carefully until zero beat is achieved. (In doing this it is helpful to adjust the oscillator level—and thereby the sideband level—to obtain the clearest beat.) When zero beat is obtained we read the frequency of the LF oscillator from the counter. The frequency in this case would be 11 kHz. The frequency of the signal being measured is the sum of the marker, 144.150 and the modulator, 11 kHz, or 144.161 kHz.

In using this method you must take care not to get confused. You must be absolutely certain which marker is the nearest, you must know whether the unknown signal is above or below the marker, you must make sure that you use the lowest possible frequency from the low-frequency modulating oscillator and you must not overdrive the modulated stage. Obviously the better the receiver dial calibration is to start with the less the chance of getting mixed up. I have found it a good practice to write down the approximate frequency as read from the dial right at the beginning, to make sure I didn't add when I should have subtracted, etc.

The system just described was set up in 1961 to measure the frequency of the Oscar I satellite. The counter was an old commercial unit with a top frequency of 150 kHz. The low-frequency oscillator was a commercial R-C audio oscillator which tuned above 25 kHz. The system worked so well that I had a try at the ARRL frequency measuring contest using it. In this case operation was in the 3.5 and 7 MHz bands and the signal being measured was W1AW. The procedure used is for W1AW to transmit for about five minutes in each band, sending long dashes with the call letters inserted at frequent intervals. Since the dashes are each only a few seconds long the precision of zero-beating is limited to a fifth of a hertz or so, even under ideal propagation conditions.

On 3.5 MHz the conditions were good and the signal in the clear. I obtained 13 readings with a total spread of 4 Hz. On 7 MHz the conditions were not as good and there was some interference. I obtained 9 readings with a total spread of 9 Hz. I corrected these figures for equipment errors (see next paragraph) and submitted the averages of my various readings for each band. The result was a top-of-the-field listing with an error of zero hertz and zero parts per million for both 3.5 and 7 MHz (see QST for June 1962, page 92).

In making precise measurements it is necessary to know what errors are in the measuring equipment. The error, if any, in the standard frequency oscillator can be determined by comparing one of its harmonics with WWV. If there is any question about whether the standard oscillator is high or low it may be resolved by twisting the frequency-adjusting trimmer. If frequent

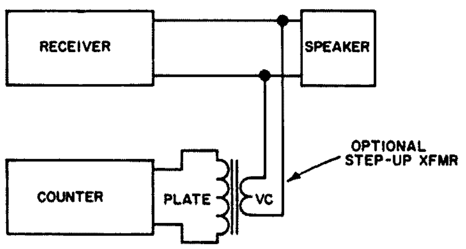


Fig. 12. Counter connected to receiver output.

adjustments are considered undesirable it may be simpler to adopt a policy of always running the oscillator off by a hertz or two at 15 MHz. This is not enough to seriously affect its use as a calibrator, but if it is always run off on the same side the correction will always be in the same direction. A second but less serious source of error is the error in the counter, or in its internal frequency standard. It is less serious because the portion of the total frequency synthesized in the zero-beating process which is contributed by the LF oscillator is very small. The simplest way to measure the counter error is to measure the marker frequency (50 kHz in my case) on the counter. If the marker reads high it is a sign the counter is reading high (its internal oscillator is low) and all counter readings must be reduced accordingly.

A good overall procedure to reduce error is the following:

1. Check standard oscillator against WWV and determine error.
2. Check counter against standard oscillator.
3. Measure unknown frequency.
   a. Note approximate frequency from receiver dial.
   b. Note nearest marker, and whether unknown is above or below marker.
   c. Estimate frequency for LF oscillator.
   d. Turn up LF oscillator level and adjust for zero beat.
   e. Read LF oscillator frequency from counter.
   f. Repeat a, b, c, d several times if possible.
4. Repeat 1.
5. Repeat 2.
6. Correct the indicated frequencies for the apparatus errors.

There are a number of tests which can be made with the counter connected to the output of a receiver. In making this connection it is a good idea to use the "high-impedance" or "6 ohm" output of the receiver if it has one, so that the counter will get a signal of adequate level without overdriving the speaker or headset. If there is no high-impedance output circuit and the counter is insensitive it may be necessary to use a step-up transformer between the speaker circuit and the counter input. An ordinary plate-to-voice coil transformer connected backwards works fine. See **Fig. 12.**

If a strong signal can be obtained from a standard frequency station or any other source known to be stable, it can be used to measure the warm-up drift of the re-

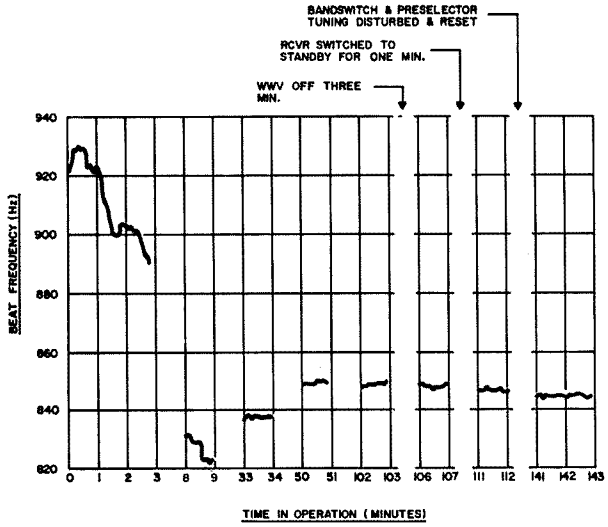


Fig. 13. Receiver warm-up drift.

ceiver. **Fig.** 14 shows a curve taken in this manner on a commercial receiver operating at 15 MHz. In this case the standard signal was the carrier of WWV. In setting up the apparatus the receiver was set for CW reception with the bandwidth adjusted to 500 Hz, and the carrier was tuned in carefully. The high selectivity of the receiver rejected the sidebands of WWV (ticks and tones), and the receiver output was a single clear beat note of about 900 Hz. After the initial adjustment, which required about five minutes, the set was turned off for 4 hours so as to stabilize in the "cold" condition.

The counter was warmed up for a few hours before turning on the receiver. After switch-on counting was started as soon as there was any detectable output. It was a simple matter to write down the frequency changes as the receiver warmed up. **Fig. 14** shows that the "peak-to-peak" drift was only 110 Hz. After warm-up, the residual drift was less than 10 Hz per hour.

With a receiver of known stability it be-

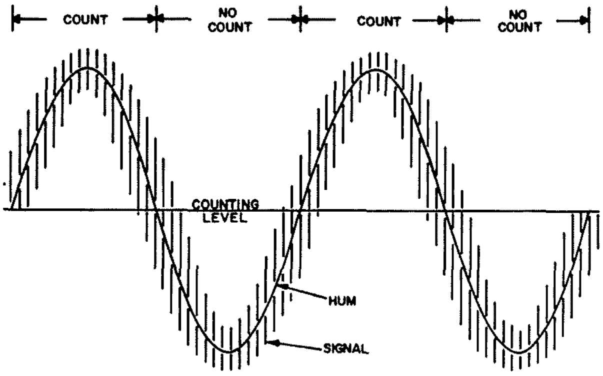


Fig. 14. Incorrect counting with multiple inputs.

comes practical to use it and the counter to measure the drift of other signal sources, such as vfo's, other transmitters, etc.

With the bfo turned on and the receiver selectivity slacked off a bit, the combination may be used to measure the shift of a RTTY transmitter. To do this it is necessary to put the transmitter alternately on steady mark and steady space for several seconds each. In most RTTY set-ups this can be done by opening the "break" switch on the keyboard. Several readings should be taken on both mark and space and each group averaged, so as to eliminate any drift in either transmitter or receiver.

Counters don't always tell the truth. Some can be made to lie by changing or subnormal line voltage, high temperature, out-of-tolerance tubes, etc. But there are times when even the best units lie. In experimental hook-ups the most frequent causes of erroeous indications are multiple inputs and modulated inputs. **Fig.** 14 may help to explain how this can happen. Here we show a counter attempting to measure the frequency of an audio signal, about 1 kHz, in the presence of excessive 60 Hz hum. The desired 1 kHz signal rides up and down on the undesired 60 Hz hum, and the counter operates only when the sum of the two signals exceeds the minimum input. As a result the counter operates in little spurts, one spurt each sixtieth of a second, and counts only about half the cycles of the 1 kHz signal. In short, the counter reads low! The same thing can happen with an amplitude modulated signal. Never try to count a modulated signal, and never try to count with more than one signal applied to the counter input terminals. When in doubt connect a scope in parallel with the counter so you can see what you are counting.

Probably we will never see the day when there is a counter in every ham shack. But the day is already here when a counter can be put to use consistently in ham operation and experimentation. If you find a surplus unit at a reasonable price don't pass it up just because the frequency range doesn't go up to 432 MHz. Grab it and see what you can do with it. And if you come up with a new application, write it up so the rest of us can try it. . . . W3GKP

Kayla Bloom W1EMV
P.O. Box 224
Dublin, N.H. 03444

The Amphenol Millivolt Commander

A Field Effect Transistor Voltohmmeter

If you are looking for a VOM with superb quality, extreme reliability, portability, and accuracy, you would do well to consider this as one of the best buys in the field.

Externally, the unit is housed in a handsome saddle-stitched carrying case. The cover can be removed easily for bench use, and, with the cover removed, the center of gravity is low making it extremely stable. There is little chance of it being knocked off the bench by accident.

This unit was checked against a highly reliable meter which had just been calibrated at the factory, and the amphenol proved to be accurate in all ranges, according to the specifications shown in the manual with the exception of the 1 KVdc position. This position read 10 volts high at 360 V dc. This is well within tolerance, however, and shouldn't deter the potential buyer.

The Ohms scale was checked with precision resistors (1%) and proved to be accurate within the indicated specifications. The AC Volts was checked on the 10 V and 300 V scales with complete accuracy. The low voltage, high impedance characteristics of the probe makes this an ideal unit for in-circuit measurements.

The power source for the Millivolt Commander consists of 2 "AA" 1.4 V Mercury cells (Eveready E9 or equivalent) and 8 "AA" 1.35 to 1.5 V cells (Eveready 915 or equivalent). The batteries used are in three different circuits. The ohms battery is discharged only when resistance measurements are being made. This battery should be replaced when the ohms adjust control will no longer calibrate the ohm range to full scale. The Zero reference battery supplies a bias potential required by the amplifier. To eliminate drift, these cells are constantly loaded by a small current. The amplifier load is approximately 0.8 mA in the dc mode and 1.2 mA in the ac mode. The unit has a built in battery test position to alert the user to possible battery failure. This battery test indicates the quality of the cells in the amplifier supply only.

The high sensitivity of the Model 870 allows measurements which are not possible on other meters. The ac sensitivity of .01 V

Specifications:

Power Source
Batteries:
2 "AA" 1.4 V Mercury cells
8 "AA" 1.35-1.5 V cells
DC Voltmeter +DCV, —DCV
Ranges:
0-0.1, 0.3, 1.0, 3.0, 10.0, 30.0, 100, 300, 1000.
Accuracy:
±2% of full scale all DC ranges.
Input resistance:
10.6 megohms on all ranges.
AC Rejection:
A voltage at 60 Hz 40 dB greater than full scale affects reading less than 1%.
AC Voltmeter—ACV, dB
Ranges:
0-.01, .03, 0.1, 0.3, 1.0, 3.0, 10., 30., 100., 300.
—40, —30, —20, —10, 0, +10, +20, +30, +40, +50 dB (—12 to +2 Scale).
Accuracy:
±3% of full scale on all ranges from 50 Hz to 50 kHz.
Input Impedance:
10 mv to 1 v
10 megohm shunted by 31 pF.
3 V to 300 V
10 megohm shunted by 20 pF.
Ohmmeter
Resistance Range:
Resistance from 10 ohm center scale to 10 megohms center scale.
Accuracy:
3 degrees of arc.
Voltage:
1.5 V open circuit.
Weight

With batteries	5 Lbs.
Without batteries	4.5 Lbs.
Shipping	8.5 Lbs.

Overall Size
9¼ x 5¾ x 6⅝ inches.
Price: $99.95

full scale, allows measurement of tape head and other magnetic transducer outputs directly. The dc sensitivity of 0.1 V full scale allows measurement of semiconductor bias levels easily. More accurate nulls can be resolved. Also, current measurements can be made with little circuit disturbance.

The decibel scale can be used to determine power level based on 0 dB = 1 mW in 600 ohms. The numerical value is indicated by meter scale and added to the dB value for the position of the range switch. The following formula may be used to convert the dB reading into watts:

$P_{(watts)}$ (1×10^{-3}) antilog (db/10)

$P_{(mw)}$ antilog (dB/10)

or, a convenient chart is given in the manual to make it easier.

In the dc mode of operation, an amplifier using a FET at the input provides impedance conversion and drives the meter. Precision voltage dividers extend the range from the basic 100 mV sensitivity and permit resistance measurement. In the ac mode, an additional amplifier provides the necessary gain for 10 mV sensitivity.

. . . W1EMV

A Poor Man's Mil Spec

Roy E. Pafenberg W4WKM
316 Stratford Avenue
Fairfax, Virginia

How often have you picked up a surplus component, marked only with a string of cryptic symbols, and wondered just exactly what it was? If you have, join the party. Today, most all electronic components destined for military applications are marked with what is known as the Military Specification Number. If this Mil Spec number is in addition to the usual value and rating markings, you are in luck. However, in many cases, the Military Specification Number is the only identification on the component.

The actual military specifications are, in general, quite voluminous and are phrased in legal-technical languages designed to fix, in no uncertain terms, the precise characteristics of a family of electronic components. While ideal from a procurement point of view, they leave the casual experimenter or non-military technician cold. These Mil Specs are difficult to obtain and just as difficult to use when all you really want to know is the value and taper of that surplus junk box "control, variable, composition".

The Industrial Electronics Division of Lafayette Radio Electronics Corporation has recognized the problem and published a guide to the simplified interpretation of Mil Spec numbers. This booklet, *Lafayette Electronic Procurement Guide and Directory**, is a limited distribution publication for Lafayette's military-industrial customers. However, Lafayette has granted permission to reproduce excerpts of their copyrighted booklet in this article. Because of space limitations and the limited utility of certain of the condensed specifications, only those of greatest value to the experimenter and technician are presented here.

. . . W4WKM

CONTROLS, VARIABLE, COMPOSITION
MIL-R-94B

Example: **RV4NAYSB104B**

	a	b	c	d	e	f	g
Explanation:	RV4	N	A	Y	SB	104	B

a) Style of potentiometer.

b) Bushing:

N	Standard
L	Locking
S	Shaft and panel seal

c) Switch:

A	None
B	S.P.S.T.

d) Temperature and Moisture Resistance Characteristics:

	Max. Ambient Oper. Temp.	Max. Resistance change due to humidity test	Min. Insulation Resistance during humidity test
X	120°C	±14%	50 megohms
Y	120°C	±10%	100 megohms

e) Operating Shaft:
First letter indicates style.

F	Flatted
S	Slotted

Second letter indicates length from mounting surface.

	Flatted ¼" Dia.	Slotted ¼" Dia.
A	—	⅝"
B	—	½"
D	—	⅞"
G	—	1¼"
K	2½"	2½"
L	—	—

f) Resistance in ohms: First two digits are significant and the last digit is the number of zeros that follow.

g) Resistance Characteristic and Overall Resistance Tolerance:

A	Linear ±10%
B	Linear ±20%
C	10% Res. at 50% C.W. ±10%
D	10% Res. at 50% C.W. ±20%
E	10% Res. at 50% C.C.W. ±10%
F	10% Res. at 50% C.C.W. ±20%

CONTROLS, VARIABLE, WIRE WOUND

MIL-R-19A

Example: **RA30NASD103A**

	a	b	c	d	e	f
Explanation:	**RA30**	**N**	**A**	**SD**	**103**	**A**

a) Style of potentiometer.

b) Bushing:

N	Standard
L	Locking
S	Shaft and panel shaft

c) Switch:

A	None
B	S.P.S.T.

d) Operating Shaft:

First letter indicates style.

F	Flatted
S	Slotted

Second letter indicates length from mounting surface.

	Flatted .¼" Dia.	Slotted ¼ Dia.	Slotted ⅛" Dia.
A	—	½"	—
B	—	⅝"	—
D	—	⅞"	⅞"
G	—	1¼"	—
K	2½"	2½"	—
L	—	—	5/16"
M	—	—	7/16"

e) Resistance in ohms. First two digits are significant and the last one is the number of zeros that follow.

f) Resistance Characteristics and Tolerance:

A	Linear Taper	±10% tolerance

RHEOSTATS, VARIABLE, WIREWOUND, POWER TYPE

MIL-R-22A

Example: **RP102FD252KK**

	a	b	c	d	e
Explanation:	**RP10**	**2**	**FD**	**252**	**KK**

a) **Style:** Denotes type of rheostat, specific size and power rating.

b) **Off Position:** Some rheostats furnished only without "off position". Types RP10, 11, 15, 16, 20, 25, 30 are available with "off" position.

Symbol	Off Position
1	No electrical off position
2	"Off" at end of counter-clockwise position
3	"Off" at end of clockwise position

c) **Shaft:** First letter describes the shaft of the rheostat. The second letter indicates the length of shaft.

1st letter	
F	Flatted
R	Round
S	Slotted

2nd letter	Round or Flatted* (±1/64")	Slotted† (±1/64")
A	—	½"
D	⅞"	⅞"
E	1"	—
G	1¼"	1¼"
H	1½"	—
J	2"	2"
K	2½"	2½"
N	4"	—
R	6"	—

*Shafts with flats:

Shaft Diameter	**Flat Length
.250" +.001 —.002	.625"
.375" +.001 —.002	1.5"

**Or to within .156" of mounting bushing where shaft is too short for flat length. Flat is diametrically opposite the contact arm.

†Not in styles RP35, 40, 45, 50, 55.

Dimensions of slot: Depth .063" +.015 —.000; Width ±.005.

d) **Resistance:** Three digit represents the resistance in ohms. First two digits are significant figures; the third represents the number of zeros that follow. The letter "R" represents a decimal point, thus the figures following the "R" are significant. Example: 7R5 represents 7.5 ohms.

e) **Tolerance:**

	Tolerance
JJ	±5 %
KK	±10%
LK	+15% —10%

RESISTORS, FIXED, WIRE WOUND (POWER TYPE)

MIL-R-26C

Example: **RW47Y152T**

Explanation: **RW47** (a) **Y** (b) **152** (c) **T** (d)

a) **Style:** Indicates size, shape and wattage.

b) **Characteristic:**

	Max. Operation Temperature	Min. Insulation Resistance at end of moisture-resistance test
G	275°C	2.5 megohms
V	350°C	2.5 megohms
Y*	350 C	100 megohms

*Y characteristics available in styles RW30, 33, 37, 47.

c) **Resistance:** Indicated by three digit number. The first two digits represent significant figures — the last specifies the number of zeros that follow.

d) **Center Tap:** Certain resistor styles under MIL-R-26C cannot be center tapped. See individual catalog listings for styles that can and cannot be center tapped. For center-tapped resistors, the power rating should be reduced 10%.

RESISTORS, ADJUSTABLE (VARIABLE), WIRE WOUND

MIL-R-19365B

Example: **RX33V152**

Explanation: **RX33** (a) **V** (b) **152** (c)

a) **Style:** Indicates type of resistor and wattage and size.

b) **Characteristic:** "V" identifies the maximum continuous operating temperature (350°C).

c) **Resistance:** Indicated by three digit number. The first two digits represent significant figures — the last specifies the number of zeros that follow.

Tolerance: Under MIL-R-19365B ±5%.

Solder

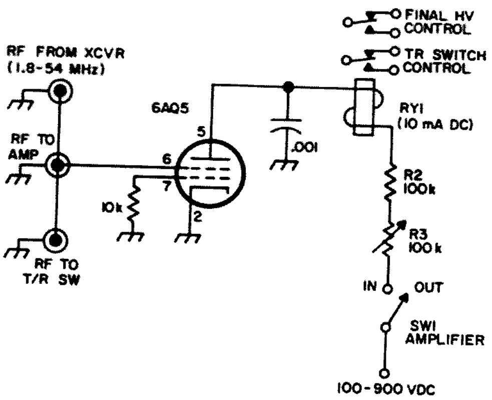
In stating solder type, the tin percentage is given first. 60/40 solder, melting at 371 degrees F., is preferable to 50/50 solder, melting at 415 degrees F. 63/37 solder melts at the lowest temperature of any tin/lead mixture, at 361 degrees F.

. . . W2DXH

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

RF Controlled Switch



So you're going to build a pair of shoes for that peanut whistle. Want to keep the control cables from the transceiver to the amplifier minimum? Build this rf controlled switch into the unit and the only connecting cable will be a coax line from the antenna terminal of the exciter to the amplifier.

Its operation is simple. During receive, the 6AQ5 is cut off, keeping the relay (RY1) open and allowing signals to pass through to the receiver. When the exciter is keyed, the rf causes the tube to conduct, pulling plate current, thus closing the relay and activating the amplifier.

Adjust R3 for smooth "kick-in" of the relay when the rf is applied. Be sure to keep the leads of C1 as short as possible to avoid any trouble with rf radiation. Because a carrier is used to key the amplifier, CW and SB are impractical. Only continuous carrier modes such as AM, FM or RTTY are recommended.

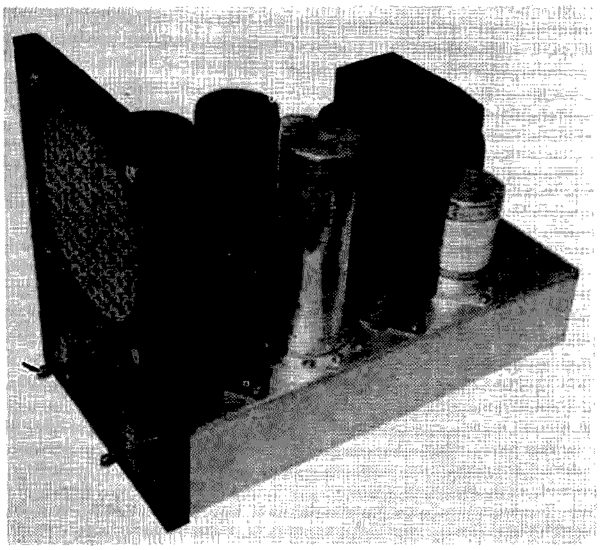
. . . WA3AQS

Call Prefix QUIZ

Let's see how up to date you are on the prefixes. List all of the W and K prefixes which are currently in use or which would be used if someone in that particular area applied for a license, in the case of Novice calls in some areas. After you've had your try at this you can turn to page 72 and see our list. 72 prefixes is average. 73 is excellent. 75 is very excellent. 78 is incredible. 80 is unbelievable.

A Transformerless Transceiver Power Supply

John Bell W5NGX
208 Pat Street
Levelland, Texas 79336



The quadrupler power supply weighs only 5½ lbs. The front panel holding the transceiver speaker is 5 x 7". The cardboard covers are on electrolytics with cases operated above ground.

Quite a few power supply articles have appeared in the ham publications in the past three years, to power the SSB transceivers on the market. An average ham can save around fifty to sixty dollars on the ac power supply by building his own. Most all of the articles written have followed the same general pattern in that they use a TV set power transformer in a full wave bridge rectifier circuit, to obtain the high voltage, from 600 to 800 volts, and use the transformer center tap to obtain the low voltage of 250 to 300 volts. Bias is usually obtained from a small isolation transformer, or a back to back filament transformer arrangement is used.

The power supply described in this article deviates from the ordinary considerably in that it uses no HV Power transformer whatsoever, but still delivers the necessary high voltage, low voltage, variable bias and filament voltage.

The circuit used is a modified, half wave quadrupler. It's not anything new, as voltage multiplier circuits have been around for about thirty years, and are covered in the radio amateur handbooks. The conventional half wave quadrupler is shown in **Fig. 1.** The incoming 120 volts ac is "multiplied" four times through the use of the four diodes and four capacitors. Actually the resultant output dc voltage is more than four times the average value of the 120 volts input, because the capacitors charge up to the peak ac value. (Peak value is 1.414 of the average). Advantage can be taken of this peak charge by using large values of capacitances. The larger the value of the capacitors, the more current can be pulled from the unit.

Referring to the schematic in **Fig. 1,** C1 has a voltage times 1 of the line voltage (peak value), C2 has twice the line voltage on it (peak), C3 has three times 120 volts (peak) and C4 has a voltage of four times the peak AC line voltage, or well over 600 volts. Here we first run into capacitor trouble, because there are no high value-electrolytic capacitors available at this working voltage. So, a modified quadrupler circuit was derived, and is shown in **Fig. 2.** This modification puts C4 in series with C2, and we can now use standard electrolytics of lower voltages for the output capacitor, plus getting a low voltage tap, at ½ of the output voltage. Again, this is not a new circuit. It is in the power supply chapter of the Radio Amateur's Handbook. The final schematic diagram of the complete power supply is shown in **Fig. 3.** Bias is a half wave arrangement taken from the hot side of the 120 volt line and ground, and consists of the components, R5, D5, R6, C5 and R4. The photographs show the parts layout although it is not critical. The supply is built on a 5 x 9½ x 2 inch aluminum chassis. The front

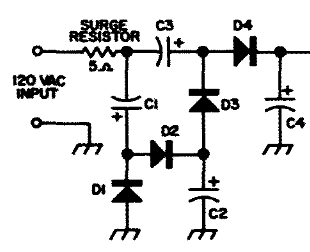
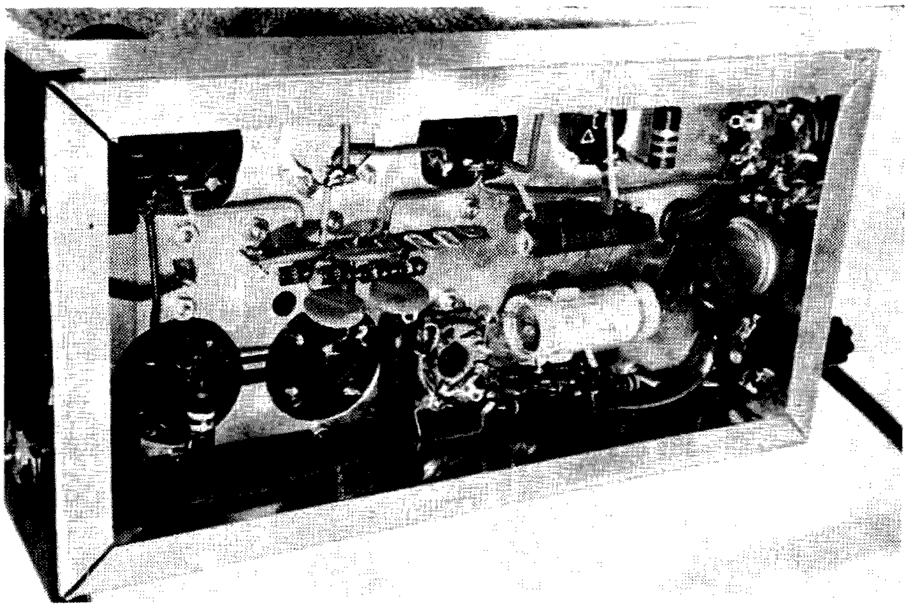


Fig. 1. Conventional half wave quadrupler. Full output voltage is across C4.



Underchassis view shows no overcrowding of components.

panel holds a 4 inch speaker, making a very compact unit.

Referring to **Fig. 3**, diodes 1, 2, 3 & 4 and Capacitors CI, 2, 3a, 3b & 4 make up the quadrupler. The one and only transformer Tl, is a 12.6 Volt at 5 Amp. filament transformer. R1 is a surge resistor to protect the diodes, because when the supply is first turned on, the capacitors look like a dead short, and the sudden inrush of current through the diodes can exceed the ratings for a few microseconds, and believe me, this is enough to ruin a silicon diode. K1 is a 30 second time delay relay, that shorts out the surge resistor after 30 seconds, which gives the capacitors sufficient time to charge up to 90% of their peak voltage.

A lot was learned from constructing this power supply. You will notice that C3 is made up of two capacitors in parallel with a 500 volt rating. When this unit was first constructed, a 200 μF, 450 volt capacitor was used for C3, and lasted for about 5 minutes, then it blew, spraying wax under the chassis and all over my workbench. Actual measurement of the voltage showed that 495 volts was across this capacitor, so we had to find a solution. Electrolytics come in the 500 volt size in reasonably high capacitance, so two 80 μF were used in parallel, but 495 volts is just too close to their maximum rating. So the value of the bleeder and equalizing resistors across C2 & C4 was lowered from 100 KΩ each to 10 KΩ at 20 watts. This brought the voltage on C3 down to a safe value of 475 volts dc.

As to the performance of this power supply, it is used on a Drake TR-3 transceiver, and they recommend a power supply with 650 volts with a regulation of 10% from 100 mA for the high voltage and 250 volts at 180 mA with 10% regulation, for the low voltage. Bias requirement is 65 volts, adjustable. With the power supply hooked up to the TR-3 and in the receive position, high voltage is 630 volts on the high tap, and 260 volts on the low voltage tap. Pressing the mike button and the final amplifier in the TR-3 drawing 100 mA of static plate current, the high voltage drops to 615 volts. On 300 mA voice peaks the voltage under load drops to 600 volts. The low voltage tap only drops about 5 volts on 300 mA voice peaks. Here's where the large value of capacitors really pay off in regulation with a capitol R: 5%. I have never, in my 20 years of hamming had a power supply that would even approach this type of regulation, because all previous power supplies I have used had power transformers in them, and they have losses and reach saturation of the core

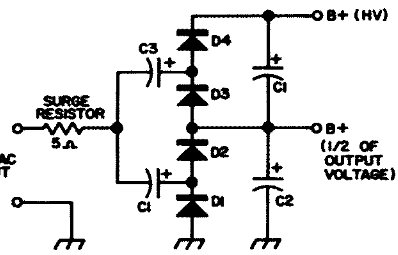


Fig. 2. Modified and redrawn quadrupler. By putting C4 in series with C2, a lower voltage capacitor can be used for C4.

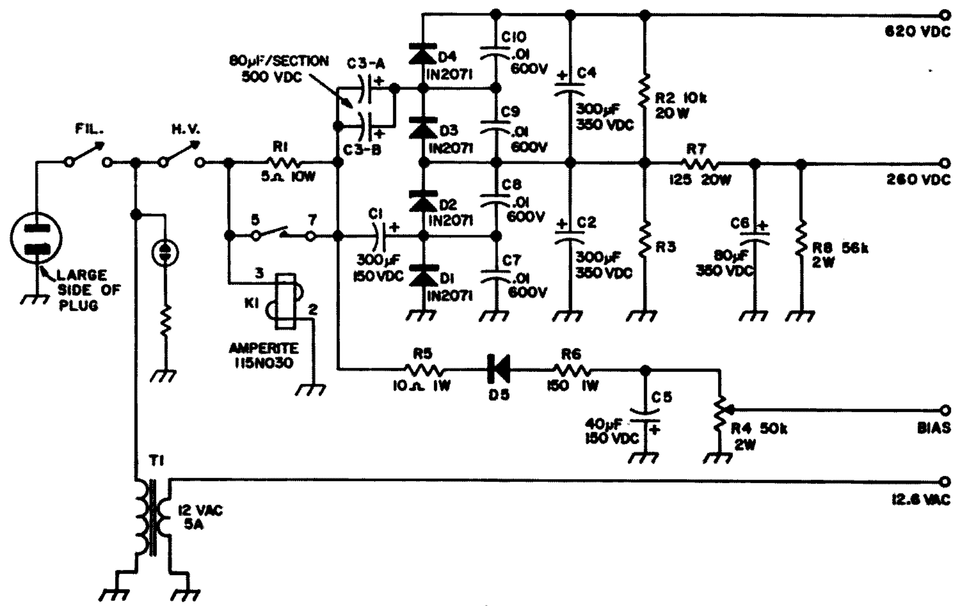


Fig. 3. W5NGX's transfomerless transciever power supply. A few safety precautions are necessary with this type of supply. The chassis is grounded directly rather than through the ac plug, and only one wire is run to the ac receptacle. The unmarked neon bulb and resistor should be for 115 vac operation.

rapidly under peaks. Six hundred volts at a total of 680 mA, plus the bleeder current, with a regulation of 5% is an excellent figure, and it certainly is a nice feeling to have a transceiver in the momentary tune-up period, drawing 500 mA of final plate current and not hearing a power transformer groaning and rattling. Another advantage is weight: This supply only weighs 5½ pounds, and a transformer-type supply of the same voltages weighs 30 pounds. Purchasing all of the parts new, this supply can be duplicated for about $36.00. This power supply runs very cool. The only component showing a very small amount of heat is the filament transformer.

Transformerless power supplies scare many hams, but if you're careful, you shouldn't have any problems. In fact, if you follow the schematic, the circuit is as safe as any other supply capable of putting out this voltage. Notice that the schematic doesn't show a wire from the ground of the plug to the chassis of the supply. The power supply chassis should be grounded directly to a GOOD ground with only one wire coming from the ac plug to the supply. All modern ac receptacles are polarized; the hot side is slightly narrower than the grounded one. Connect the single wire from the power supply to one pin of a regular ac plug and solder part of a paper clip over the other pin. Now the plug can only be inserted one way, and if your house is wired properly, the pilot blub in the supply should light when you turn on the filaments. If it doesn't, you should check your house wiring.

With this set-up, the supply simply doesn't work if you have the plug reversed since there is no voltage on it. But you MUST have a good ground for the chassis; if the ground isn't good, the chassis could be slightly live.

A few other precautions: Don't turn on the supply without a load as it could damage the capacitors or diodes. Don't short out the high voltage with a screwdriver just after you've turned off the supply. Let the capacitors discharge about five minutes.

I hope I've made a good case for transformerless power supplies. If a few safety precautions are followed, they are not to be feared and they work well.

. . . W5NGX

Cool-Amp

Metal parts can be silver plated without a special bath by using Cool-Amp powder, supplied by the Cool-Amp Co., 8621 S.W. 7th Ave., Portland, Oregon 97219.

. . . W2DXH

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ACL for the C E 100V and 200V

ALC circuits are the vogue and have some real advantages when you want to get through and still not put your exciter and amplifier into flattopping. Jim Kyle's excellent writeup in the Jan. '65 73 gave most of the details, but here is information on ALC applications to the Central Electronics 100V and 200V.

On these CE rigs, there are no *if* stages, and the grids of the mixers are all tied up in a bias string which makes the conventional means of ALC insertion impossible. Here is one solution for the 200V. This was made up for both exciter and linear ALC, but it works if only one is used.

The ALC signal from the PA grids is taken from the wiper of R422 (bias readjust rheostat to grid of 6550 PA tubes). This is easiest to reach at the terminal strip of the driver transformer (w-bk-gn wire).

The bias string is isolated from the 1st mixer tube during transmit by inserting a diode in the sideband generator to mixer lead so it will conduct during standby, but not on transmit. This point is reached by snipping the white lead off at R402 and inserting the diode. The signal is inserted between the diode and R402.

For internal ALC only, a five lug terminal strip with all components fits nicely in the rf exciter compartment with no wires to run. Additionally, external ALC from the linear signal can be fed into the compartment, then to the socket from one of the jacks on the rear panel.

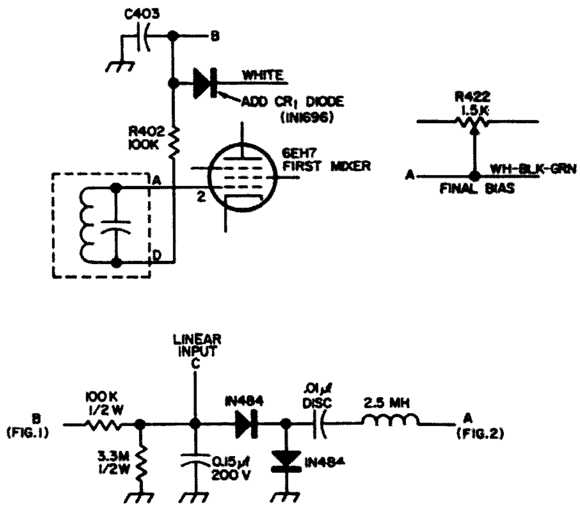

Fig. 1. Schematic diagram for ALC circuit. 1N484 or equivalent should have high back resistance. CR1 (1N1696) should be rated for 300V PIV. Feed ALC from linear into point C.

Operation of the 200V alone showed a complete lack of distortion products on its scope and when the NCL 2000 linear was used, grid current was held to less than 1 mA, no matter how much input was used. Incidentally, I have found the best method of proper tune-up is by testing with a friend who has a strong signal with no skip conditions present.

. . . K1AQI

The Electronic Invasion

We've read a lot about electronic snooping in the newspapers, but not so much in our electronic journals. Bob Brown W2ZSQ has gathered the facts for us in the 184 page book published by Haden Books, 116 West 14th Street, NYC 10011. While most of the book discusses the state of the art, there are some circuit diagrams for bugs, bug detectors and bug jammers. This aspect is rather lightly treated though. It is particularly interesting to read the debunking of some of the more popular myths about bugging.

Radio Control Manual

This new book is radio control circa 1968, transistorized and very sophisticated. The book, published by Tab Books, Blue Ridge Summit, PA 17214, at $3.95 in paperback, starts with the fundamentals and is quite satisfactory as a text for a course in radio control. There are home construction projects and just about every one of the 192 pages has at least one circuit diagram. If you are interested in radio control you'll need this book.

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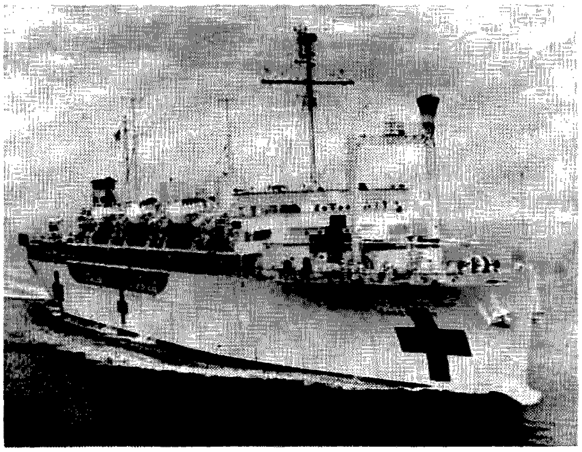
Ships of Mercy

Twenty minutes from the battlefield to a hospital bed aboard the USS SANCTUARY and her sister ship the USS REPOSE. These two Navy hospital ships ply the waters of the South China Sea from Chu Lai to the DMZ doing admirable duty in saving the lives of many casualties helicoptered aboard. Each is a floating hospital of 750 beds, staffed with expert physicians, nurses, medical technicians and hospital corpsmen, on call 24 hours a day. The mission of both ships is to provide hospitalization services for U.S. Armed forces personnel.

Both ships have complete amateur radio facilities. The equipment on the SANCTUARY is the Collins KWM-2A with a 30L-1 linear and a Johnson Matchbox but since the later part of January a Henry 2K-2 linear has been added. The antenna now in use is the Telrex 99D with rotor. It is 175 feet above the water on the Mainmast. The equipment on the USS REPOSE is the 32S3 transmitter with the 30S1 linear and the 75S-3B Collins Receiver. The antenna

Photo courtesy of U.S. Navy

RMI George Beaver running a phone patch for Lance Cpl. Gail Bartle (USMC) of Yorktown, Indiana, to his mother.



Official U.S. Navy Photo

The U.S.S. Sanctuary. A hospital ship near the battle area which supplies immediate medical aid to the wounded in Viet Nam.

system is Telrex with a Telrex rotor. The antennas are on the Rearmast up 145 feet above the water.

The amateur radio station aboard the USS SANCTUARY first went on the air April 13, 1967, off the coast of Vietnam, using the call WA4LGD. Unfortunately after two weeks using this call, the operator Gene Nation (WA4LGD) had to give up operating the station due to sickness. For several months afterwards, the call WB6VXT was used until the licensee, Jim Lencioni, was transferred back to stateside. On October 10th, George Beaver, WB4HVF, became custodian and chief operator of the station.

More than 3000 phone patches have been completed since the station started operations on April 13, 1967. Most are routine but at times drama or humor can be heard. For drama, a mother learning for the first time that her son has been wounded. The courage of some of these fellows is something to behold, some with arms or legs missing. They take it in stride and, as Chief Operator George Beaver remarked," I am no more patriotic than the next guy but, for the first time in 15 years in the Navy, I feel I am doing something worthwhile. You work 17 to 18 hours a day and fall in bed exhausted . . . . . . but you feel good."

On the USS SANCTUARY there are three more hams in the crew who work with George Beaver, WB4HVF, and they are Dennis Shultz, WA3IHH, Frank Stover, WA3HPX and Bill Crosby, WAØKEN who just reported aboard in December. Others who volunteer for work in the ham shack,

on their free time, are Lt. Finucan, Jim Monk, Richard Pease and Bob Reilly.

With a large crew and a full capacity of patients aboard the ship, the ham shack is a busy place when the phone patching gets underway. Ambulatory patients form lines by the ham shack, sometimes 15 or 20 at a time, while the bed patients are patched into the ham shack from their beds.

Many west coast operators are part of a team that handle the phone patches from the USS SANCTUARY and the USS REPOSE. Some who have regular schedules with these ships are Syd Fass, W6NZ of Berkley, California, Dean Burnett, W6BJ, of La Mirada, California, Jim Smith, W6RT, of Solano Beach, California, "Slats" Johnson, W6KVH of Riverside, California, Frank Sarver, W6AOR of Van Nuys, California, George Cooper, W6PKK, of Hollywood, California, Bill Barge, WB6DIU, of Lawndale, California, Richard Levor, of Capistrano, California, Howard Shepherd, Jr., W6QJW, of Los Angeles, California, Southern California VHF Club of Paramount, K6BPC, Gerry Johnson, K7YRU, of Kent, Washington, George Murphy, of Cowallis, Oregon and O. R. Queen, W7KYM of Phoenix, Arizona. There may be more regulars that deserve mentioning but if we missed anyone may we say "Thanks for Your Dedicated Work".

In some communities funds are raised to pay for the long distance calls of the servicemen who are patients aboard the SANCTUARY and the REPOSE. Through the efforts of Dean Burnett, W6BJ and the editor of the local paper, *The La Mirada Lamplighter*, the civic organizations of La Mirada, California have organized a SANCTUARY-REPOSE FUND. The mayor with other business men of the city take care of handling the contributions which come from many sources. In Seattle, Washington, Gerry Johnson, K7YDO has an arrangement to pick up the tab on long distance calls through the generosity of the local Veterans of Foreign Wars post. Plans are being arranged in other cities for civic organizations to contribute to this type of phone patching.

Words of praise should go to the long distance operators of the telephone companies who handle the phone patch calls. These girls are exceedingly interested in having the calls completed even though many require time to locate people in distanct places. As one of the phone patch radio amateurs remarked, "The telephone operators are really good. They will find them if they are to be found." When phone patching is at it's peak usually one long distance operator will take ten to fifteen calls and she will have them all ready to talk, one right after the other. Sometimes it takes a couple of hours to clear all the calls but the operators stay right on the circuit. There are also cases where company officials have assisted in locating hard to find parties, sometimes at all hours of the night. Phone patching is a necessary part of life these days and the phone companies are doing all they can to help with the morale of our servicemen.

Hundreds of letters of appreciation have been received from the families of the wounded men on the hospital ships, thanking the phone patching amateur radio operator for arranging the call from the ships. One letter received was from a woman expressing her thanks and explained that she forgot to show her appreciation to the operator after talking to her son. In her excitement of being able to talk to her son, she did not find out the name of the radio amateur who did the phone patching. She waited for her monthly telephone bill to arrive and then had the telephone company trace the name and address of the radio amateur so she could express her thanks. There is no doubt that all recipients of phone patch calls are thankful for hearing and talking to their loved ones.

This story would not be complete without mentioning Rear Admiral George H. Reifenstein, W3CKN/K6LZI who has taken great interest in phone patching by other radio amateurs who are of extreme value to the morale of the patients aboard the hospital ships. Although his work at The National Medical Naval Center in Bethesda, Maryland does keep him very busy, he does find some time to participate in amateur radio activities. At present he is working with temporary antennas from his home in Bethesda but will shortly have a three band beam in operation. When he lived on the west coast, his station, K6LZI, was very active operating C.W. and SSB.

With phone patching so important to the morale of our servicemen, might we mention that frequencies should be kept clear from QRM so that phone patch calls from these ships can be completed.

. . . K6GKX

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Amateur Applications For Inexpensive Tape Recorders

In this article we will explore how, with simple modifications, one of the inexpensive tape recorders, widely available, can be used for a variety of functions for either the phone or CW operator.

The consumer radio market is overflowing with a number of inexpensive tape recorders costing as little as $10. The quality of some if these units for home entertainment might be somewhat debatable, but for amateur use, where restricted frequency response and some variation in tape speed are tolerable, they can be put to a number of interesting uses. The obvious use is as a CQ caller for phone work. However, they can also be used as a CQ caller on CW by use of a transistor switch.

Additional uses consist of a compression amplifier, and a CW monitor/keying shaping circuit. All of these functions can, in fact, be built into one tape recorder simultaneously by the use of relatively few parts.

This article presents the conversion information separately for these functions so the reader can incorporate as many or as few as are desired to suit his situation.

The basic circuit of most inexpensive recorders is similar to that shown in **Fig. 1.** A 4 or 5 stage transistor audio amplifier serves as a microphone amplifier to drive the recording head in the record position, and then as a playback amplifier to amplify the playback head pickup to drive a loudspeaker in the playback position.

In order to be able to use the amplifier as a microphone amplifier also, either with or without a compression feature added, another position has to be added to most recorder selector switches, to allow microphone amplification with the speaker connected to the output, instead of to the recording head.

On some recorders, another switch, with an additional position, can be substituted for the present selector switch Other recorders, which do not allow selector switch substitution, will require a separate switch. The output to the microphone input of the transmitter can most simply be taken, via a 1 μF capacitor, from the primary of the output transformer (as shown in **Fig. 1**).

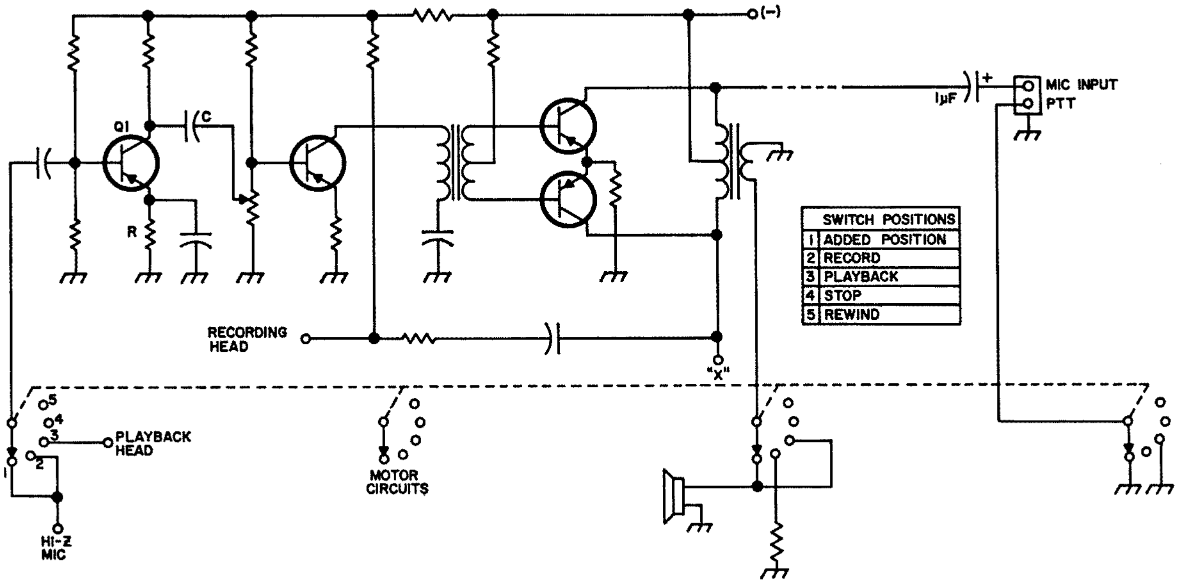


Fig. 1. Typical small recorder amplifier circuit with an extra position added to the selector switch to enable the use of the amplifier as a microphone preamplifier.

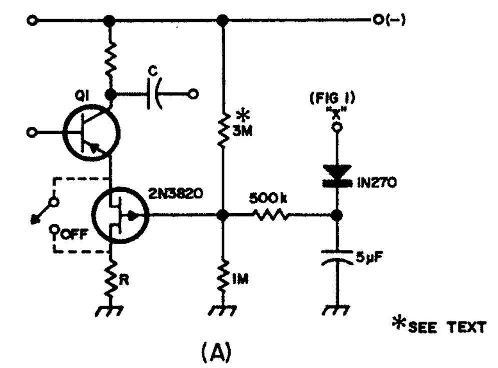
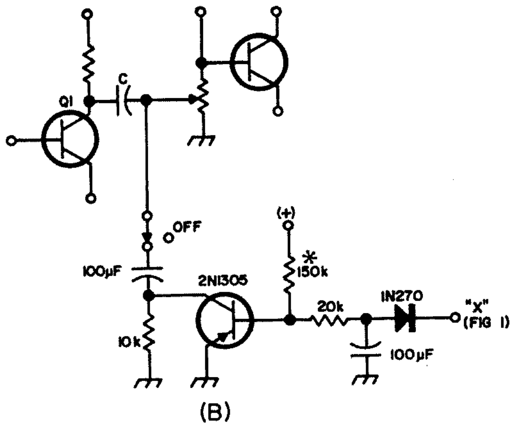


Fig. 2. Two simple feedback control circuits which can be added to a recorder audio amplifier to make it into a compression amplifier.



Some recorders have a monitor output which can also be used.

If push-to-talk operation instead of VOX is used for the transmitter, the relay control circuit lead from the microphone can be carried through the recorder by using miniature 3 circuit jacks and plugs, or an additional contact on the recorder selector switch can be used to energize the transmitter in the microphone amplify and playback positions. It might be possible, in some recorders, to utilize existing ground contacts on the switch for motor control for this purpose.

Almost all simple compression circuits operate in some manner to reduce the output of the first audio amplifier stage as a function of increasing overall amplifier output. This is accomplished by rectifying part of the output and using it as a control voltage to regulate the characteristics of a control transistor which modifiies the gain of the first audio amplifier stage. Two methods which are easily adapted to simple recorder circuits are shown in **Fig. 2.**

In **Fig.** 2(a), the drain and source connections of a FET transistor are placed in series with the emitter resistance of the first audio amplifier. The bypass capacitor normally used across this resistor must be removed or it will act to "wash out" the variations in the control action. Removal of the capacitor will reduce the overall gain of the audio amplifier somewhat, but usually not enough to cause difficulty.

In operation, increasing the output from the amplifier produces an increasing positive control voltage at the gate of the FET. This, in turn, cuts off the FET, increasing its source to drain resistance and, hence, the negative feedback of the first audio amplifier stage.

The circuit of **Fig. 2(b)** uses a similar principle. Increasing audio amplifier output produces a negative control voltage which decreases the collector-emitter resistance of the control transistor, and more effectively bypasses the 100 μF capacitor to ground. The output of the first audio amplifier is reduced, because its output is increasingly bypassed to ground. No changes are required in the original recorder amplifier circuitry. The 3 megohm resistor shown going to a negative voltage in **Fig.** 2(a), and the 150 k ohm resistor going to a positive potential in **Fig. 2(b)**, act to prevent compression action from taking effect until a certain minimum output level is reached. This allows the amplifier to operate at maximum gain for low-level input signals. These resistors may not be necessary in all cases and their value can be varied for best compression action. Both circuits will provide very effective compression with about a 20 to 0 db control range.

If desired, a switch can be added, as indicated in **Fig. 2**, to switch out the compression action.

In order to use the recorder as a CQ caller on CW either of two methods can be used. A SSB transmitter will produce a single carrier output when a single sinewave audio signal is fed into the microphone input. Therefore, approximately a 1,000 Hertz keyed tone can be recorded and played back into the transmitter audio input. It is important, however, that the tone be a pure sine wave of constant frequency, or spurious carrier outputs will emanate from the transmitter. Recorder speed variations will change the output tone, and the length of the call must be kept short if a

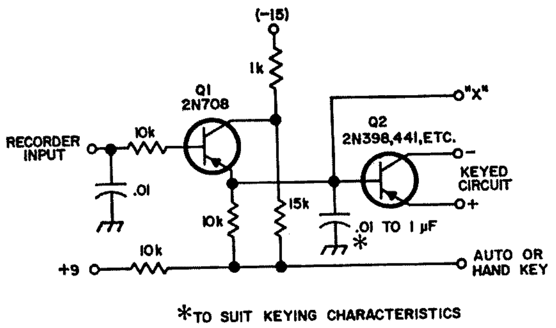


Fig. 3. Two stage switch used to modify a recorder as a CW CQ caller.

recorder without a constant speed capstan drive is used.

The requirement for a pure audio tone can be eliminated by using the recorder to operate a transistor switch, connected directly across the contacts of the transmitter keying circuit, rather than using the recorder output to feed the transmitter directly. One circuit for doing this is shown in **Fig. 3.** Basically, the recorder output used to make Q_1 in turn causes Q_2 to conduct and and key the transmitter. The ratings of Q_2 determine the maximum keyed voltage and current ratings.

Q_2, as shown in **Fig. 3,** can only be used with grid-block keying systems having less than 100 V open circuit voltage, or with cathode keyed circuits operating at less than 20 mA.

In contrast to the previous keying method, it is desirable that the recorded keyed tone be as close to a square wave as possible, rather than a pure sine wave.

If desired, the station key can be connected between Q_1 and Q_2 instead of keying the transmitter directly. Because of the low voltage across the key when it is used in this manner, sparking is essentially eliminated. By experimenting with the RC combination in the base of Q_2, it is possible to achieve almost any degree of hard or soft keying characteristics.

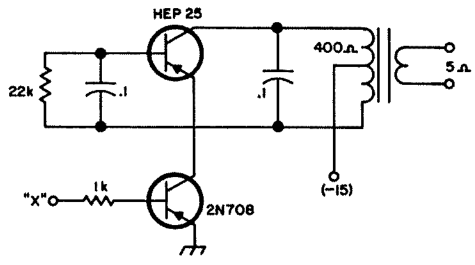


Fig. 4. CW monitor with additional switch which can be added to the circuit of Fig. 3.

If the transmitter does not have a keying monitor, one can easily be included in the keying circuit as shown in **Fig 4.** It can be activated either by the CW station key or the recorder output.

The keying/monitor circuit can be assembled on a small piece of vector board and mounted inside of the recorder enclosure or, in the case of ultra-miniature recorders, in a separate mini-box.

. . . W2EEY/1

Prefix Quiz Answers

We count 78 W and K prefixes. We are not perfect, but we are pretty perfect.

W1, K1, WA1, WN1
W2, K2, WA2, WB2, WN2
W3, K3, WA3, WN3
W4, K4, WA4, WB4, WN4
W5, K5, WA5, WN5
W6, K6, WA6, WB6, WN6
W7, K7, WA7, WN7
W8, K8, WA8, WN8
W9, K9, WA9, WN9
WØ, KØ, WAØ, WNØ
KA2, KA5, KA7, KA8, KA9
KB6, WB6
KC4, KC6
KG1, KG4, KG6, WG6
KH6, WH6
KJ6, WJ6
KL7, WL7
KM6, WM6
KP4, WP4, KP6
KR6, KR8
KS4, KS6, WS6
KV4, WV4
KW6, WW6
KX6
KZ5

That's 78 prefixes. Did we miss any? And how many did you miss? Sorry about those KN and WV prefixes, but they are all out of date now.

Electronic Engineering Nomographs

Over 100 nomographs of conversion charts, attenuators, filters, transmission lines, passive components, tubes, transistors, etc. Nomograph fans will go right out of their minds at this collection. Published by Tab Books, Blue Ridge Summit, PA 17214, $9.95, a big book and spiral bound. 175 pages.

Surplus Conversions

Hardly a week goes by without receiving many requests from readers asking where to find information regarding a particular piece of surplus gear they have picked up without a manual or any conversion information.

In addition to the following literature, *73's Index to Surplus* should give all the information as to where to find conversion for almost any surplus equipment. This handy reference is available from 73, Peterborough, N.H. 03458 for the modest sum of $1.50.

Editors and Engineers

Editors and Engineers, P.O. Box 68003, New Augusta, Indiana, have published three *Surplus Radio Conversion Manuals* by Evenson and Beach and the *Surplus Handbook, Vol. I* by W6NJV and W6NJE. Each costs $3. Here are the pieces of equipment covered in each manual:

Surplus Radio Conversion Manual, Vol. I. BC-221, BC-342, BC-312, BC-348, BC-412, BC-645, BC-646, SCR-274 (BC-453A and BC-457A series), SCR-522, TBY, PE-103A, BC-1068A/1161A.

Surplus Radio Conversion Manual, Vol. II. BC-454, AN/APS-13, BC-457, ARC-5, GO-9/TBW, BC-946B, BC-375, LM, TA-12B, AN/ART-13, AVT-112A, AM-26/AIC, ARB.

Surplus Radio Conversion Manual, Vol. III APN-1, APN-4, ARC-4, ARC-5, ART-13, BC-191, BC-312, BC-342, BC-348, BC-375, BC-442, BC-453, BC-455, BC-456-9, BC-603, BC-624, BC-696, BC-1066, BC-1253, CBY-5200, COL-43065, CRC-7, DM-34, DY-2, DY-8, FT-241A, MD-7/ARC-5, R-9/APN-4, R-28/ARC-5, RM-52-53, RT-19/ARC-4, RT-159, SCR-274N, SCR-508, SCR-522, SCR-528, SCR-538, T-15 to T-23/ARC-5, URC-4, WE701A.

Surplus Handbook, Vol. I. This book, subtitled, *Receivers and Transceivers,* is composed of schematics and pictures of the following gear. It doesn't give conversions. APN-1, APS-13, ARB, ARC-4, LF and VHF ARC-5, ARN-5, ARR-2, ASB-7, BC-222, BC-312, BC-314, BC-342, BC-344, BC-348, BC-603, BC-611, BC-624 (SCR-522), BC-652, BC-654, BC-659, BC-669, BC-683, BC-728, BC-745, BC-764, BC-779, BC-794, BC-923, BC-1000, BC-1004, BC-1066, BC-1206, BC-1306, BC-1335, BC-AR-231, CRC-7, DAK-3, GF-11, Mark II, MN-26, RAK-5, RAX, RAL-5, Super Pro, TBY, TCS, VT tube cross index.

CQ Handbook

CQ has two handbooks on surplus out. They can be ordered from CQ, 14 Vanderventer Avenue, Port Washington, N.Y. The first book, the *Surplus Schematics Handbook,* by Ken Grayson W2HDM, costs $2.50, and contains schematics and short comments about this gear: APA-38, APN-1, APR-1, APR-2, APS-13, ARB, ARC-1, ARC-3, ARC-4, ARC-5, ARC-5 VHF, ARJ-ARK-ATJ, ARN-7, ARR-2, ART-13, ASB, AS-81-GR, ATK, BC-AR-231, BC-189, BC-191, BC-221, BC-312, BC-314, BC-342, BC-344, BC-348, BC-375, BC-438, BC-474A, BC-603, BC-610, BC-611, BC-620, BC-640, BC-645, BC-652, BC-653, BC-659, BC-683, BC-684, BC-728, BC-733, BC-745, BC-779, BC-794, BC-906, BC-969, BC-1000, BC-1004, BC-1023, BC-1206, BC-1335, BN, BP, C3, CRC-7, CRO-208, CRT-3, DAE, F3, GF-11, GO-9, GRR-5, 1-122, 1-177, 1-208, JT-350A, LM, Mark II, MD-7, MN-26, PRC-6, PRS-3, R-174, RAK, RAL, RAO-7, RAS, RAX, RBH, RBL, RBM, RBS, RC-56, RC-57, RDC, RDR, RDZ, RU-16, SCR-274, SCR-284, SCR-288, SCR-300, SCR-506, SCR-522, SCR-578, SCR-585, SCR-593, SCR-608, SCR-610, SCR-624, SCR-628, SPR-1, SPR-2, TBS, TBW, TBX, TBY, TCK, TCS, TG-34, TS-34/AP, TS-251/UP, VRC, VVX-1.

The other CQ book, the *Surplus Conversion Handbook* by Tom Kneitel K3FLL, ($3) contains conversion on these pieces of gear: ARC-1, ARC-3, ARC-4, ARC-5, ARC-36, ARC-49, ART-13, ATA, ATC-1, BC-191F, BC-224, BC-312, BC-314, BC-343, BC-344, BC-348, BC-375E, BC-453, BC-454, BC-455, BC-457A, BC-458A, BC-459A, BC-603, BC-604, BC-620, BC-624A, BC-625A, BC-659, BC-669, BC-683, BC-684, BC-696A, BC-779, BC-794, BC-946, BC-1004, BC-1068A, CBY-52232, PE-73, PE-103, R-129/U, RAX-1, SCR-177, SCR-188, SCR-193, SCR-274N, SCR-399, SCR-499, SCR-508, SCR-509, SCR-510, SCR-522, SCR-528, SCR-542, SCR-608, SCR-609, SCR-628.

Additional Notes on the IC Electronic Counter

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The article in February on the IC counter has apparently generated a considerable amount of interest. Unfortunately, several errors appeared in the diagrams that might cause trouble. When I checked the copies of my original drawings I found that many of the errors were my own, for which I am sorry. I should have checked the drawings more carefully.

In **Fig. 4**, C1 must go to the 0 output on the JK and output can be taken from the 1 output. In **Fig. 3** all of the 0 and - outputs are reversed. This makes no difference on the JK flip-flops on which both the S and C inputs are grounded, but on every JK where S and C inputs are not grounded either the S and C inputs must be reversed or the 0 and 1 outputs reversed (not both!). The 1 kHz signal from SI can come from either output of the fifth JK from the left in the top row.

In **Fig. 5**, C1 should be 100 pf. The 10K resistor to the right of R3 should be marked R4. IC6 can be a Fairchild 900, not 800.

In table I., the truth table for **Fig. 6**, the row B, A, D, C, F, E, H, G, should be $\overline{B}$, $\overline{A}$, $\overline{D}$, $\overline{C}$, $\overline{F}$, $\overline{E}$, $\overline{H}$, $\overline{G}$. In **Fig. 6**, "D" should go to the 1 output of IC2. IC10 thru IC12 can be the same types as IC5 thru IC9.

On page 7, the last digit vacillates because of the one cycle per gating period or one count per gating period error inherent in a digital counter. This is one place where it is still correct to use cycles since we mean cycles per gating period and not necessarily cycles per second. The error will be 1 Hz with a 1 second gate, 10 Hz with a .1 second gate or 100 Hz with a .01 second gate, etc.

The cost of the oscillator in **Fig. 2** can be reduced by using a Motorola MPF-102 instead of the 3N126. It is advisable in this case to reduce the oscillator supply voltage to a value between 9 and 12 volts regulated.

A decade using incandescent lamps appears in February, 1968 Popular Electronics, page 27. It has nicer looking lamps than the neon decade and is available in kit form at a price slightly less than that of the neon decades with parts bought separately. The kit includes a printed circuit board making construction easier. To use it, pins 1 and 3 on IS-1 of the units decade must be lifted from ground and used for the gate input and the lamp blanking circuit on the present counter must be modified to give 6 volts.

Pin connections for the IC's can be found in reference 6 or from the manufacturer's data sheets. The more recent Motorola data sheets designate the outputs of a JK flip-flop as Q and $\overline{Q}$. Q is the same as 1, $\overline{Q}$ is the same as O. All IC's in the counter must be supplied with +3 volts V_{cc} and ground even though not shown.

To test a decade before the rest of the counter is built an IC electronic keyer such as the Micro-Ultimatic or the Kindly Keyer is a good signal source. Output must be taken from one of the IC's, not from the relay contacts. Another possibility is to build a "noiseless switch" using two gates or inverters connected as a flip-flop as in **Fig. 1**.

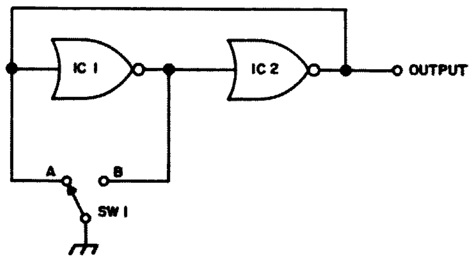

Fig. 1. Noiseless Switch for testing decades. IC1 and IC2 can be any gate, inverter or buffer. SW1 can be any type switch, preferably momentary, and can even be a piece of wire touching A and B alternately.

The builder can build as few or as many decades as he wishes but adding decades of the same type as shown does not increase the frequency range since this is limited by the units decade and is slightly over 10 MHz. for the decade shown. To go higher in frequency more expensive IC's such as

the Motorola MECL series would be needed for IC8 and IC9 in **Fig. 5** and for the units decade only. Another approach would be to beat the unknown frequency with a crystal oscillator to get a frequency below 10 mHz. The frequency of a transmitter above 10 mHz can be determined by using the counter to measure the fundamental oscillator frequency if it is below 10 mHz provided the other stages are known to be multiplying correctly. . . . W1PLJ

Soldering Is Easy

P. Stankiewicz, WB2ZNC

Well, soldering is exactly what I've said it is—easy. Even if it is quite simple one can have some of the wildest experiences with soldering, as I have. The most frequent of these is when you go to knock that excess of solder off the iron and it lands right on you. If there's one thing that can give you a nice jolt, that's hot solder. This knocking the solder off can also lead to other circumstances. The one time I can remember was when I hit the iron so hard on the table that the tip cracked right off. One of my not so frequent stunts is grabbing the iron as if it were a pencil. After much pain and a few scorched fingers, I discovered what that handle was for.

How about that time when you had some real tight work. There it was, that little connection buried down in there among countless wires, capacitors, and resistors—how to get that iron in there with that big fat tip was another problem. Mine usually end up in a mass of melted insulation, scorched capacitors, and a huge blob of solder wedged in there. The connection usually isn't even touched with the iron or solder.

What about soldering guns. Did you ever press down on that connection a little too hard, and have the tip do a right angle bend?

Well, so much for the soldering guns and irons. How about the solder? Solder on a spool is easy to use, except when someone solders it all together. Another thing is that one can rarely spend more than a half-hour over a soldering gun before becoming asphyxiated by the smoke.

Oh, oh. I've got to stop now since I just remembered I put the iron down on the very seat I'm sitting on. That's all for now 73*eeeeee!!!* . . . WB2ZNC

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Reviewing the Heath HW-16 CW Transceiver

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If you're jaded with high power SSB operation and tired of short-range QSOs on the VHF bands, how can you put some life back into your hamming?

If you live in a tiny apartment and are putting most of your time into the intellectual pursuits on a university campus, what do you do to keep your operating hand in?

Revert to the womb, go back to the good old days, soak yourself in nostalgia and get your kicks—that's what you do.

Fix yourself up with a lower power CW transmitter, a reasonably sensitive and selective receiver, an old J-38, and a handful of crystals for various spots around the CW bands. Hook it all up to a decent antenna and you can be back in the swing of it in no time at all.

There's hardly anything easier to build than a QRP CW rig. Crystals are cheap. A J-38, or similar key, is easy to come by. And modern technology permits small, inexpensive receivers with excellent sensitivity and selectivity.

So, you get all set to put together just such a rig. You reach for the parts catalog and the Heathkit wish-book falls off the shelf. By coincidence, it flips open to the pages showing equipment designed for Novice operation. You decide to take a look at some Heath circuits. Maybe you can pirate a good idea for the transmitter you hope to build.

What's this? A three-band CW transceiver? With a price tag that won't cut into next semester's tuition? You pick up the book and take a closer look at the Heathkit HW-16.

The piece turns out to be a complete, crystal-controlled transmitter and separate VFO-tuned receiver in a small, table-top package. The receiver tunes the first 250 kHz of 80, 40, and 15 meters. That means you can work 40 after classes in the afternoon; you can check into that 80 meter traffic net later in the evening; and you can start on a really challenging DXCC on 15 meters; what with the sunspots opening the band to all points on the globe.

Bandswitching is in one front-panel switch and transmitter tuning is simple. All you do is dip the final plate current reading on the front panel meter—or peak the power output reading on the meter, whichever you choose. There is a power level control on the front panel which lets you vary the screen voltage on the 6GE5 final, raising or lowering the input power of the transmitter. That way you can stay within Novice limits or boost the rig's input to over 100 watts.

There are separate af and rf gain controls on the front panel so you can operate the way you used to, running the af gain wide open and adjusting the rf gain for listening level.

To keep operation simple, the only other controls Heath has put on the front panel are the large (1¾ inch) main-tuning knob (which has that important smooth and hefty feel) and two sizes of crystal sockets.

Key jack, speaker output jack, earphones jack, antenna jack (phono type), ground connector, VFO input jack, and VFO power output socket are all on the rear chassis apron.

Inside, the rig is quite simple and straight forward.

The transmitter uses a 6CL6 as a modified Pierce crystal oscillator and buffer amplifier. The signal from that stage is amplified by the second 6CL6, the driver. The driver stage functions as a tripler to 21 MHz for 15 meter operation. The final is a 6GE5 getting 600 volts from a voltage-doubler power supply. Low-power transmitter and receiver sections receive 300 volts from the power supply. The primary of the power

transformer is protected by a circuit breaker and turned ON/OFF by a switch on the af gain control.

Grid-block keying controls the flow of cutoff bias to all three transmitter stages.

The front-panel meter measures a sample of rf output voltage at the antenna ("Rel Pwr") or final cathode current ("Plate").

Stray transmitter rf, which might tend to migrate toward the receiver sections, is kept out of the receiver's rf amplifier stage by by-passing to ground. A silicon diode, acting as an "antenna relay," is biased during transmit operation, permitting flow of current to ground only. During receive, the diode is unbiased and is effectively an open circuit at low received-signal voltages.

The pi network is used in both transmit and receive. Incoming signals follow a path through the receiver from the rf amplifier to a heterodyne mixer (with fixed-tuned heterodyne oscillator) to a VFO mixer (with manually-tuned VFO) to an *if* amplifier, an xtal-controlled product detector, and two audio amplifiers.

The manual rf gain control varies the amount of cathode bias on the rf amplifier tube (6EW6). It also controls the cathode bias to the 6EW6 *if* amplifier.

The heterodyne mixer is ½ of a 6EA8 and the heterodyne oscillator is the other half of that tube. The VFO and mixer share another 6EA8. The VFO tunes 1900 kHz to 2150 kHz. The *if* is at 3396 kHz. A 500 kHz crystal filter couples the VFO mixer output to the *if* amplifier grid(6EW6).

One-half of a 12AX7 is the bfo, crystal-controlled at 3396.4 kHz. The other half of that tube is the product detector which produces an audio signal equal to the difference in frequency between the bfo and *if* of the two input signals. The product detector output goes through the af gain control to two halves of an 6HF8, twin-stage audio amplifiers. The final audio is coupled through a transformer to either speaker or headphones (speaker connected at all times). When the 'phones are plugged in, their high impedance mutes the speaker. There is a 2N1274 bias switch for receiver muting.

So, you consider a compact, three-band, crystal-controlled, good-looking transceiver, with full break-in and built-in sidetones so you can hear your own fist in the speaker or 'phones. You send in your check and the twenty pounds of gear comes by return mail. You unlimber the trusty soldering iron and spend a few hours wiring the rig. You make typically Heathkit-simple alignments. And you hook up a 50 ohm, unbalanced antenna.

Having gone through the thick and thin of ham radio over 14 years, you need a vacation from building and testing wierd, special-purpose antennas. You have little room for anything fancy. So, you invest in a Hy-Gain 18AVQ and relax (after pounding in four eight-foot ground rods).

You dig through the recesses of your apartment-sized junkbox-in-a-suitcase. Crystals at 3625 kHz, 7007 kHz, 7025 kHz, and 7044 kHz turn up. They will hit the three bands just right. The old J-38 comes out of the junkbox. A cotton swab makes a good cleaner for the key contacts and your old Novice call where it is scratched into the wood-block base.

You hook everything together and warm up the transceiver. Firing it up on 40, you call a W8 in Toledo. He comes back with a FB signal report. You tell him he's your first with a new Heath HW-16 CW Xcvr. He says your signals are loud and clear despite strong QRM on the band. Later, you have a solid QSO with a W2 in New York and another with a W4 in Georgia, both on 80. The next morning you fire up for a quick check on 15 at mid-morning. It sounds as if the entire Communist bloc is on the air, so you plunge right in, working three countries toward that new DXCC.

One of your hang-ups is contest operating—nothing hot-shot, just leisurely. Not the little contests, but the SS, VE/W, DX, FD, and like that. You check the calendar. The VE/W contest is coming up in a couple of weeks so you make the necessary arrangements with the XYL for a free weekend.

The contest weekend arrives and you knock off about 7000 points with easy operating. You work all the Canadian geographical areas, save one. At three a.m. Sunday on 40 mtrs you connect with a 3C5/VE8 and you know the little rig is sweet.

. . . K3RXK

Dilemma In Surplus

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Do you have an AN/TSQ–1? I had one for about three days, after which time I was obliged to sell it back to its original owner. Besides the one I had there is one other, and I wouldn't be at all surprised to learn that it is in the hands of some ham who intends, perhaps, to salvage parts from it or convert it into something useful around the shack. What, you want to know, is an AN/TSQ–1? Well, that's something that I can't really answer. I have a feeling that I was just beginning to discover its capabilities in the fashion of the blind man examining the elephant. I got it working so that it did something, but it probably has potential that I didn't even suspect.

My introduction to the "Tisk–One" came on a Saturday morning last June while I was on one of my periodic scrounging trips to Andy's Super Surplus Store. Andy has quite a variety of odds and ends, all of military origin. Here one could find everything that was required to equip an army—twenty years ago. According to local legend, Andy has, from time to time, done a very lucrative business with various persons from Central America. Knowing Andy as I do, I'm sure this is nothing but rumor and imagination. His pricing policy, if he has one, is a secret he keeps to himself, though I am positive that no one will ever accuse him of not operating by the profit motive. Basically he is a man of considerable integrity and as honest as anyone I know.

This Saturday morning Andy's curt greeting and dejected look signaled his feelings as soon as I walked in the door. Directing me to a huge pile of junk in his back room, he explained that he had been tricked into buying a bunch of worthless surplus from a nearby Air Force base engaged in research and development work. It seems that he had made a bid on a group of items that included some slightly used uniforms and field packs. It wasn't until his bid had been accepted that he found that he had also purchased a truck full of assorted electronic equipment. Normally Andy didn't like to stock much radio or other electronic gear as he found the demand rather unstable. Usually, when I wanted something specific, I would ask him for it and within a week or two he would locate it somewhere and buy it for me.

His new purchase was a windfall for me and I quickly selected an armful of priceless items which I would be certain to need when I finally got around to building my super-dooper band-blaster. Then I came upon the "Tisk–One", packed in three olive drab, metal shipping cases. It looked brand new and was complete with everything, it seemed, except instructions, a fact I quickly pointed out to Andy. It looked like there were some good high-voltage filter capacitors in it as well as some other components that could be useful. There was no sense letting him know that it was just the thing I needed; It would probably cost more than I could afford anyway. Naturally I was surprised when he let me have the whole thing, metal shipping cases and all, for twenty-five bucks.

Examining my find at home I began to think I had gotten a pretty good bargain. It didn't have that smooth mass-produced look of production models, but it was very well built and obviously new. One of the units was sure to be a power supply. It had a very ordinary looking ac line cord and a single ON/OFF switch. Its packing case held a large cable that was evidently intended to connect it to the second unit, which appeared to be the heart of the device. Its inside was crammed with some of the most sophisticated electronics that I have ever seen. This was definitely state-of-the-art construction, or perhaps beyond the state-of-the-art, as most of the world knows it. It had, on the front panel, a set of buttons like a push-button telephone and a single button labeled "ACTIVATE". The third unit looked very similar to a small refrigerator and was made to be connected to the second unit with a cable provided for that purpose.

Why not connect it up and see what it does, I thought. Surely that couldn't hurt and might prove to be very interesting. Being one of those persons who thinks instructions are something to be used only as a last resort, their absence didn't bother me. I was sure that my analytical mind could ferret out the secret of this device with

just a little experimentation. While hooking it up I was thinking about the possible uses it might have. Obviously the business end of this thing was the box-like unit with the door on it. It was roughly cubical in shape, about eighteen inches on a side. Perhaps it was designed to process, in some way, something that was put inside this box. What were the possibilities? The inside of the box provided no clues, as it was a plain metal box, the walls about an inch thick, possibly insulated. Could it heat or cool? X-ray? Irradiate? Speculation, it appeared, was useless, so I decided to go ahead with an "on-the-air" test. Upon plugging it in and turning it on, a previously invisible sign with the word "STANDBY" lit up just next to the "ACTIVATE" button. Amazing! What had been a plain metal panel became a postage-stamp-sized sign. This would bear investigating, but still the primary problem puzzled me: What did this thing do? While pondering this, the "STANDBY" sign went out and an "OPERATE" sign winked on. Why not, I thought, and punched the "ACTIVATE" button, expecting almost anything. Anything, that is, except what happened. Nothing. Not a thing. It just sat there and said "OPERATE". So it appeared the machine was going to challenge my ingenuity. This, I could see, was going to require some deeper consideration.

Of course it didn't really matter if I got it to do anything or not, since I was just going to disassemble it for parts, but I knew that I would be bothered by my curiosity, at least until I had exhausted all possibilities. Since the box part of it was certainly meant to hold something, I decided that it needed something to work on. So I popped an ash tray into the box and again hit the button.

And it was gone! The ash tray had disappeared! A solid cast aluminum ash tray had vanished without so much as a trace of ash or dust remaining.

Well, that's the important part of the story. The next day I "disappeared" some other things without the slightest idea of what was happening to them or where they were going. I was still as innocent of its purpose as I had ever been and now a little scared to boot. I was playing with power and forces whose magnitude I couldn't even imagine.

Monday morning during breakfast I was visited by an Air Force major and some fellow from a very large electronics firm I hesitate to name. The civilian explained that the object I had, the AN/TSQ–1, had been built by his company and was being tested by the Air Force. The tests showed it to be unsatisfactory, though he didn't say why. Nor did he offer to explain just what it was supposed to do, or how it happened to get in with a batch of surplus equipment. Considering the price I paid for it, the major made a very generous offer to buy it back. Without being given the option of saying no, or bargaining, I accepted the cash he handed me and watched them load it into their car.

As they left I did hear the civilian remark to the major that he hoped the other one would be as easy to find. This, of course, makes me believe that somewhere, somehow another one has gotten outside the area of their control, possibly the same way mine did. If this is the case and if it should happen, in some way, to fall into the hands of a radio amateur, I hope that person will tell me about his experiences. I won't call him a crackpot or say he is imagining things, because I will know he has something really different. Whatever it is, the AN/TSQ–1 is a piece of hardware right out of the future and I want to know more about it. ■

Getting Your Higher Class License

Part III — Oscillation, Feedback, and Harmonics

So far in this study course for the new Advanced class license examinations, we have gone into radio wave propagation and single sideband. This installment has somewhat more immediate practical application for the homebrewer—and warrants even closer study if you happen *not* to be a soldering-iron addict. This round, we're dealing with some principles of transmitter design, construction, and operation.

The questions from the FCC study list which we're examining this month are:

5. What are harmonics? How can the generation of excessive harmonics be avoided?
12. How do parasitic oscillations affect circuits? What can be done to prevent or eliminate parasitics?
13. What is backwave radiation? How can it be eliminated?
17. What are some common types of oscillators employed in amateur equipment? How can each be identified in circuit diagrams? What part does feedback play in these oscillators? What points in the circuits should be coupled to provide good feedback?
18. Why is neutralization important in amplifiers? What points in an amplifier circuit should be coupled to provide good neutralization?

As usual, we will shuffle these questions around a bit to pick out the subjects common to all five, then set up some new questions to bring up the key details of these common subjects. Incidentally, these are not all of the questions on transmitters; two more installments later will discuss the rest.

Of the five we're examining this month, two deal directly with oscillation and a third deals with the prevention of oscillation by neutralization. All three of these, indirectly, are involved with feedback. A good question for us, then, is "What is feedback?" and a natural companion to that one is "What are feedback's effects?".

"Backwave" is connected rather intimately with the keying of CW transmitters. Let's examine the whole area, with the question "How can CW transmitters be properly keyed?"

And harmonics are always with us. In this case, let's use one of the commission questions: "What are harmonics?" However, to go deeper, let's not restrict ourselves to the prevention of excessive harmonics; instead, let's ask "How can we use harmonics properly?"

Finally, let's return to the subject of oscillators and try to answer the question, "How many types of oscillators are there?" These six questions should provide enough answers for the five on the study list, even with their multiple parts.

What Is Feedback? Feedback—in its most general meaning—is apparently one of the most basic ideas in existence. One example of it is the concept of "cause and effect"; any time the effect "feeds back" and modifies the cause, resulting in any action, we're seeing feedback at work.

As another example, when you come to the end of this page and turn the sheet to continue reading, that's feedback. Your eyes told you that the page had been completed, and your hand turned to a fresh page. This feedback of information from eye to hand resulted in the eye receiving new input, in the form of the fresh page.

As we normally use the term, though, we tend to think of feedback as something bad—like a cold—which happens to us only when we're unlucky. When the mike line picks up rf and we transmit an annoying series of howls rather than speech, we say "Feedback!" When the final decides not to wait for any rf to reach it, and takes off on its own, oscillating wildly, again we yelp "Feedback!" And we're right. The only thing bad about it, though, is that we have *uncontrolled* feedback at work.

Fig. 1 shows the basic principle of feedback in block-diagram form. A little of the output of an amplifier is "fed back" to provide an input signal. In any practical rf amplifier, we can't help feeding back at least some of the output to the input. After all, we're radiating

our signals throughout all space—and the input of the amplifier is also in that space. This doesn't always cause trouble, though, because we can make the portion of the output which reaches the input as small as we like, by proper shielding and circuit layout.

Some types of circuits are more sensitive to feedback than others, and some types of components have feedback built right into them. For instance, a high-gain amplifier is more sensitive to any kind of signal than one with a lower gain. And a triode tube, with its high grid-plate capacitance, has a built-in feedback path.

What Are Feedback's Effects? Contrary to our general beliefs, the effects of feedback are not always disastrous. In fact, as pointed out a few paragraphs back, any cause-and-effect relationship involves feedback. Without feedback, we couldn't function.

The oscillator, a necessary item in both our transmitters and our superhet receivers, is an example of this. Feedback is essential to the working of any oscillator.

The kind of feedback which gives us trouble is uncontrolled feedback. So long as we have it under control, feedback is useful.

But in order to control it, we must know its effects. Up until now, we've been talking about feedback in general. From here on, we will talk about feedback only as it applies to an ac signal. After all, that's the kind of feedback we're most interested in, in examining amplifiers and oscillators.

All ac signals have not one but two characteristics, known as "amplitude" and "phase". Amplitude is the quantity we most often call "voltage" or "current"—the relative "strength" of the signal. However, voltage or current must be specified as peak-to-peak, RMS, or "average"; amplitude is only relative and needs no units or modifiers. Phase refers to the number of full cycles since some arbitrary starting point for the signal, with all full cycles removed from the calculation so that only a fraction of a cycle remains. Relative phase between two signals of the same frequency, for example, refers to a difference in *time* between the starting points of the two signals. Normally, phase is called either "leading" or "lagging", depending upon which signal began first, and is measured in "degrees" with 360 degrees equal to one full cycle.

A phase difference of either 0 or 360 degrees means that the two signals have no phase difference at all.

A phase difference of 180 degrees means that one signal reaches its most positive peak value of amplitude at the same instant that the other reaches its most negative peak value, and that both signals pass through zero amplitude at the same instant. In other words, one is the mirror image of the other.

Two signals of identical amplitude but 180 degrees phase difference cancel each other out. If amplitude is equal and phase difference is 0 degrees, the result is a single signal with twice the amplitude of either of the original signals. If the phase difference is anything other than 0 or 180 degrees, the result will be a single signal differing in both amplitude and phase from either of the original pair.

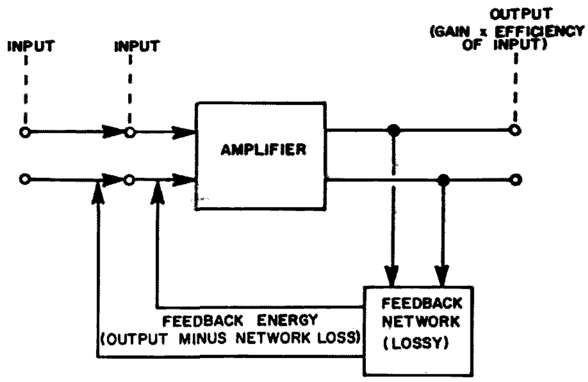


Fig. 1. Here's how feedback works. The feedback network takes amplifier output and reduces it to the desired "feedback fraction". This feedback energy is applied to the input and either cancels out or adds to the actual input energy, to produce the "effective input". The effective input is amplified so that output is equal to effective input times amplifier gain.

When we take the circuit of **Fig. 1** and apply a bit of the amplifier's output back to its input as an additional input signal, we can always control both the amplitude and the phase of the "feedback" signal. This statement is true only if the feedback is deliberately designed into the circuit; accidental feedback cannot be controlled.

Suppose, for instance, that we had an amplifier with a gain of 10, and that we take 1/10 of its output back to the input. Suppose, additionally, that we arrange for this feedback signal to be exactly 180 degrees out of phase with the input signal which produces it.

A 1-volt input signal, in the absence of the feedback, would produce a 10-volt out-

put. One-tenth of this, or 1 volt, is used as feedback. Since it is 180 degrees out of phase, it would exactly cancel the original input signal.

But this leaves us with no input signal at all, and this in turn makes the output level zero. One-tenth of zero is still zero; this means we have no feedback now. Nothing is available to cancel out the input, and output comes back to 10 volts.

The apparent contradiction here actually doesn't happen in fact, because it takes a finite amount of time (even though it's only a few billionths of a second) for the feedback to appear and do anything.

For example, when the 1-volt input is first applied the output rises to 10 volts—but to get there it must pass through all the voltage values between 0 and 10. And as it does so, 1/10 of each of those voltage values is fed back to the input. When output level is at 1 volt, feedback is 1/10 volt. This cancels out 1/10 volt at the input, leaving 9/10 volt effective input signal. By the time this loop is closed (because of the amplifier's built-in time delay) the output has already risen some. If it is up to 2 volts by this time, the feedback is 2/10 volt and the effective input is cut down to 8/10 volt. With 8/10 volt input the maximum output value is reduced from 10 to 8 volts; before this can level off, though, the output has still been rising.

When output level gets up to 5 volts, the feedback voltage has risen to 5/10 volt. This leaves an effective input level of 5/10 volt; since the amplifier's gain is 10, the output level with a half-volt input will be 5 volts. Output level stops rising and stays fixed at the 5-volt level.

The net effect of feedback upon this amplifier, then, was to reduce the gain from 10 to 5.

Any time the feedback voltage is 180 degrees out of phase with the input signal, the primary effect is to reduce the amplifier's gain. The amount of gain reduction depends upon the original gain of the amplifier, and upon the amount of feedback. Gain can be reduced almost, but never quite, to zero. Remember that any gain value less than 1 represents an actual *loss* in voltage or current (but may represent a gain in power, and frequently does so). The cathode follower is an excellent example of such a use of feedback; in this case 100 percent of the output is fed back to the input. Gain is always less than 1.

Let's take that same example amplifier with a gain of 10 and try another application of feedback to it. Let's feed back only 1/100 of its output this time, but we'll feed it back with zero phase difference. This—in-phase feedback—is known as "positive" feedback; feedback out of phase (180 degrees difference) is known as "negative" feedback.

With an input signal of 1 volt, output without feedback is 10 volts. The feedback, 1/10 volt, adds to the input signal though, raising it to an effective 1.1 volts. Output then rises to 11 volts. This increases feedback-plus-original input to 1.11 volts, and output comes up a little more to 11.1 volts. The loop goes on and on, with output climbing a little higher each time. Every increase in the output increases the input signal by 1/100 as much, and in turn increases the output by 1/10 as much.

While it might appear that the process could never end, it comes to a practical halt when the new increase in feedback signal is so small that it's smaller than the random noise level always present in any electrical circuit, and the output will stabilize at about 1.11111111 volt (the exact number of decimal places to include depends entirely upon the accuracy of your test equipment).

If we increase the positive feedback percentage to be 5/100 of the output with the gain still fixed at 10, we get similar results but with a much larger increase in effective gain.

A 1-volt input gives 10 volts out, and a feedback signal of 1/2 volt. This raises the effective input to 1.5 volts and gives us a 15-volt output signal. This, in turn, increases the feedback signal to 3/4 volt and brings effective input level up to 1.75 volts. Output, in turn, climbs to 17.5 volts. Now the feedback amounts to 7/8 volt, or 0.875 volts, and effective input climbs to 1.875 volts. Output comes up to 18.75 volts.

No matter how many times we follow this loop around, though, the output will never get higher than 20 volts with a 1-volt input signal. In fact, it won't even reach 20 volts in any practical number of repetitions. Since it takes only a few billionths of a second for our signal to make the trip around, it can reach the 20-volt level rather rapidly.

To prove that the 20-volt level can't be

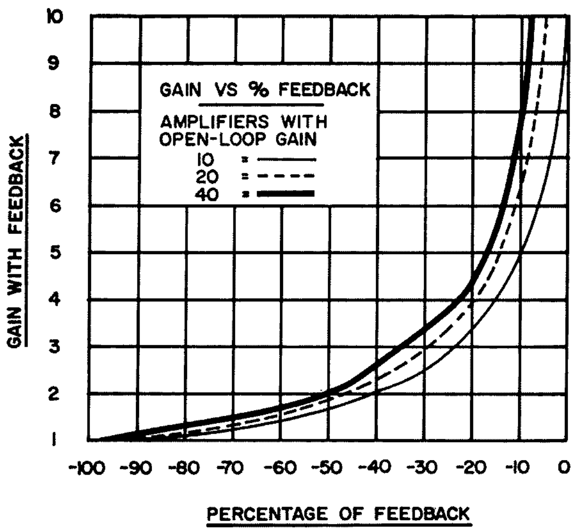


Fig. 2. Gain-with-feedback for various feedback fractions ranging from 100% negative feedback up to 10% positive feedback.

exceeded, let's assume that we have reached the 20-volt point. Our feedback fraction is 5/100 so the feedback voltage is exactly 1 volt. This 1 volt adds to the original 1-volt input for 2 volts effective input. The amplifier's gain of 10 brings this up to 20 volts. But that was the output we assumed we already had; there was no increase in output.

If we increase the feedback percentage to 99/1000 of the output, we get fantastic gain from our originally modest amplifier. Without going through the loops to prove it (you can, if you like, just as we did above), we'll just say that the effective gain is 1000. This is 100 times greater than that of the amplifier alone.

What we have been showing is that negative feedback always reduces gain, and positive feedback always increases it.

In older days, positive feedback was known as "regeneration" and negative feedback as "degeneration"; you may find this language on examination questions since it is still in wide use among oldtimers. One of the clearest examples of the use of positive feedback is the regenerative receiver.

The effects of feedback upon gain are wrapped up in a single algebraic formula which is just as worthy of being memorized as is Ohm's law. It goes:

$$\text{Gain}_{fb} = \frac{\text{Gain}}{1 - (\text{FB}) \times (\text{Gain})}$$

And means that the gain *with* feedback is equal to the gain *without* feedback, divided by the remainder when the product of feedback fraction and gain is subtracted from 1. If feedback is negative, the sign of the feedback fraction is also negative and the "subtraction" process turns into addition. If feedback is positive, the feedback fraction is positive and the product is subtracted from 1.

The results of this formula are shown as graphs in **Figs. 2** and **3.** These graphs were traced from several produced by an electronic digital computer solving the feedback formula for amplifiers with fixed gains of 10, 20, 30,, and 40, and show the gain-with-feedback for various feedback fractions ranging from 100 percent negative feedback up to 10 percent positive feedback.

Notice how rapidly the gain-with-feedback figure climbs, in **Fig. 3,** when the product of feedback fraction and amplifier gain gets close to 1. With amplifier gain of 10 and feedback fraction of 10 percent, or amplifier gain of 20 and feedback of 5 percent, or gain of 40 and feedback of 2.5 percent, the gain figures run right off the top of the scale despite several changes of scale calibration.

A look at the formula shows why this happens. When the product of feedback and gain equals 1, and feedback is positive, the gain-with-feedback becomes Gain/0. Division by zero, though technically not possible, appears to yield a quotient of "infinity." This would indicate that gain becomes infinitely large under such conditions.

Assume, for example, that we take our gain-of-10 example amplifier and put in 10 percent positive feedback. We already know that if it has 9.9 percent (99/1000) feedback, it has a gain of 1000 and that increasing the feedback any more will increase the gain also.

Remember, too, that every circuit has at least a microvolt or so of random "noise" signal circulating at all times.

This millionth-of-a-volt "noise" signal would be amplified by at least 1000 times to produce a 1-millivolt output, with 9.9 percent feedback. With feedback of 9.99 percent, the output would be 10 millivolts. With 9.999 percent feedback, we would get 1/10 volt output. With 9.9999 percent, 1 volt out. The closer we get to 10 percent, the closer the gain becomes to "infinite".

But if gain is "infinite", then we need have no input signal at all—not even the

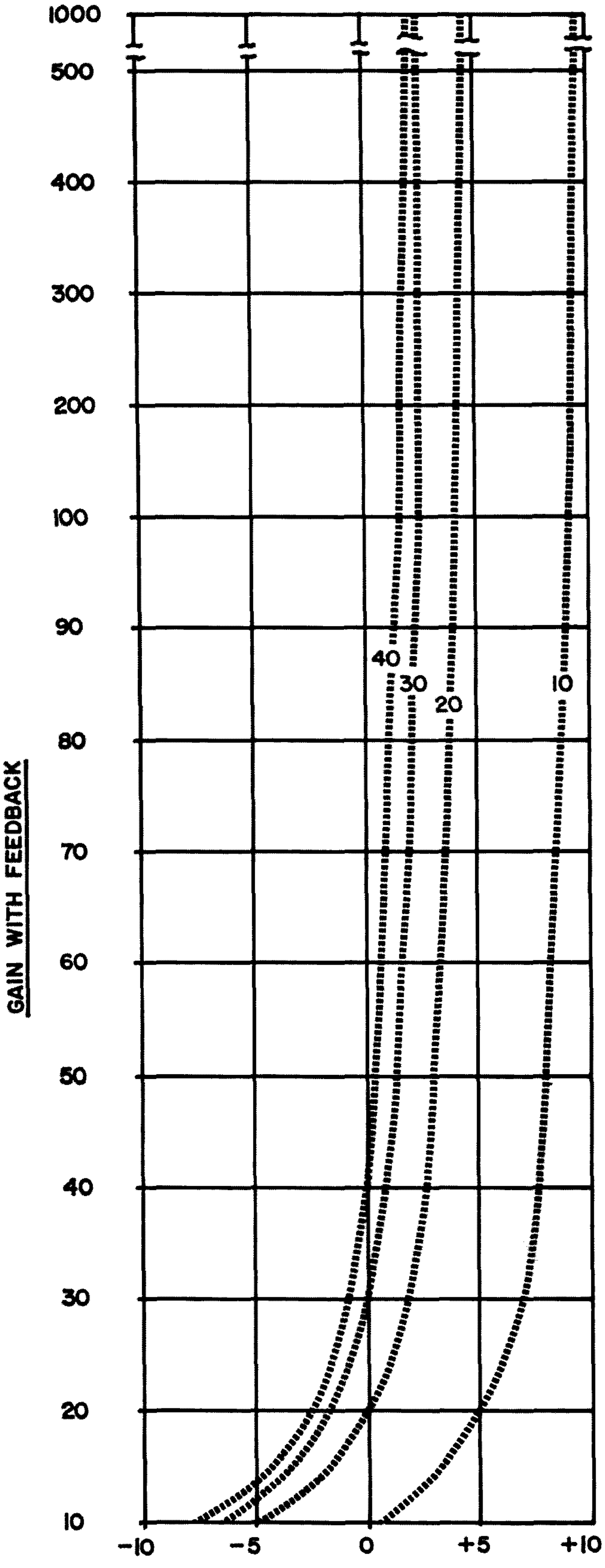


Fig. 3. The gain-with-feedback figure climbs rapidly when the product of feedback fraction and amplifier gain gets close to 1.

inescapable "noise"—to produce all the output we might want!

The result is that this amplifier is now producing all the input it needs; no "outside" input is necessary. We have, in fact, made it into an oscillator.

That simple factor, feedback fraction times amplifier gain, is actually an indication of whether any circuit can oscillate. Whenever the product of positive feedback fraction and amplifier gain is equal to or greater than 1, then the circuit not only can but *must* oscillate.

And this fact is the reason why we have spent so much time developing the idea of feedback, in order to answer questions about oscillators, parasitics, and neutralization. Now that we know why a circuit can oscillate, we're ready to look at the details.

We have two major types of feedback, positive and negative. To oscillate, a circuit must have positive feedback, and the "criterion of oscillation" that feedback times gain must equal 1 (or more) must be satisfied. Any less feedback will prevent oscillation.

If both positive and negative feedback are present in a circuit, that feedback with the smaller feedback fraction will cancel out part of the other kind, so that the result is always just one kind of feedback—but with a smaller amount of it.

This means that if we have an amplifier which has, by accident, enough positive feedback built into it so that it oscillates, we can deliberately add some negative feedback to cancel out part (or all) of the positive feedback and halt the oscillation.

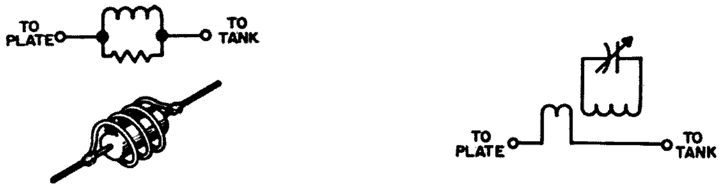
This process is called "neutralization" when it is applied to an rf amplifier.

In some cases, it's easier to visualize the neutralization process with some other images of it, but it always involves putting in some negative feedback to make oscillation impossible.

"Parasitics" are oscillations in an rf amplifier (or other rf circuit) which are not wanted and which have no apparent relation to the desired functioning of the circuit. For instance, many amplifers in the HF range (3-30 MHz) have parasitic oscillation in the VHF range between 40 and 400 MHz.

These oscillations usually occur because of accidental feedback paths from output to input, which are effective only at the higher frequencies. Often, they are due to

Fig. 4. Parasitic suppression is simple to accomplish. These suppressors kill gain at the parasitic frequency without appreciable effects at the desired frequency of operation. See text for details.



(A) (B)

physical charactistics of the tubes and other circuit components. For instance, the connecting leads from amplifier-tube plate to its tank circuit may show up as a high-impedance resonator at VHF, while the tube's gain may still be adequate to make oscillation possible.

In addition to providing spurious and illegal output signals, parasitics are rather destructive to equipment. Since they were not accounted for in the original design or in the operating and tune-up procedures, they often cause tubes to draw excessive current. The high voltages generated by the resulting unloaded oscillator also cause breakdown of insulation and overheating of coils. And it's almost an inviolable rule that an amplifier full of parasitics won't amplify the intended signal properly. The parasitic changes the tube's operating point in an unpredictable manner. Linear circuits become mixers, mixers act as distortion generators, etc.

Fortunately, parasitics are relatively easy to control once they are identified and traced to their originating stage. The control is so easy that most published construction projects, and virtually all factory-designed gear, includes parasitic suppression as a basic part of the design. The trick is simply to destroy gain at the parasitic frequencies. Then oscillation is impossible.

Two of the most common techniques for killing gain at parasitic frequencies are shown in **Fig. 4.** The simplest of the two works in most cases, and is recommended whenever the parasitic is at a frequency far removed from that at which the circuit is supposed to operate.

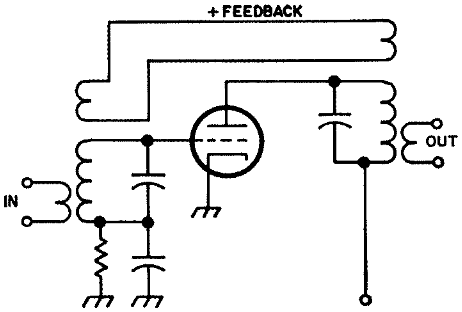
This suppressor consists simply of three or four turns of No. 18 or No. 20 wire wrapped around a 47-ohm 1- or 2-watt composition resistor. The wire acts as a tuning coil, tuned by its own distributed capacitance, for the parasitic frequency, and the resistor swamps out the Q of the circuit. This reduces gain below the critical amount needed for oscillation. At the normal operating frequency, the few turns of wire have almost no effect except—and this is vital—to short out the resistor so that it can't affect normal operation either.

When parasitics occur close to the desired operating frequency, though, the simple and direct approach doesn't do much except cut down on desired output and burn up suppressors. Then the link-coupled suppressor of **Fig. 4** must be used. In this one, the trimmer capacitor and small coil together couple all the parasitic energy out and trap it, without affecting output at the desired frequency. The trapping tank reduces circuit gain at the parasitic frequency so much that it can't oscillate, but has little or no effect at operating frequency. This is especially recommended for the 50-MHz operation and higher frequency use.

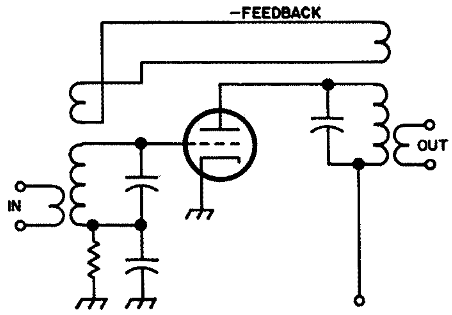
Another key point in the prevention of parasitics is to take care in construction of the circuit originally. Make sure that no "sneak" paths exist to couple output back to input at parasitic frequencies. Use single ground points whenever possible. VHF and UHF operators normally experience less parasitic troubles than do their HF brethren, simply because the construction care required to make VHF and UHF amplifiers function at all also acts as built-in parasitic suppression. The moral is: build every rig as if it were a UHF unit, and less parasitic problems will result.

When we *want* a circuit to oscillate, we still want to be certain that it oscillates only at the frequency we desire. Contrary to some beliefs, it's not only possible but easy for an oscillator to suffer parasitics. It's only more difficult to find them, since the desired rf oscillation is always in the circuit and many of the standard tests for parasitics (output in the absence of input, etc.) do not apply.

At low power levels, such as those in-



(A)



(B)

Fig. 5. Similarities between oscillator (A) and neutralized amplifier (B) are shown here. Particular type of neutralization shown is called "link neutralization" since link coupling of input and output are used. Note that only difference is reversal of connections between links, to reverse phase of feedback energy.

volved in most oscillators and all receiving rf amplifiers, and at low frequencies, one of the most effective parasitic-stoppers is a 1000-ohm ½-watt composition resistor connected to the grid pin of the tube, in series with all other grid connections. This reduces gain slightly, but the reduction is much more marked at parasitic frequencies than at the normal operating point.

While we're on the subject of oscillators it's a good time to go into some of the details we need about them. The only major difference between an oscillator and a neutralized amplifier is the phase of the feed back. It follows that there are as many ways to arrange an oscillator circuit as there are to apply feedback around a loop—and each way has its own name.

When dealing with rf oscillators, though, we find there are two major classes. All, of course, are tuned to some specific frequency, and the classifications deal with their tuning.

The two major classes are "fixed tuned" and "variable frequency" oscillators. Most "fixed tuned" oscillators employ quartz crystals as their tuning elements, and consequently the more common names for the classes are "crystal" and "variable frequency" oscillators.

This isn't the right place to go into extreme detail on how a quartz crystal works. We'll just say for now that it acts the same as a very-high-Q tuned circuit, and looks the same to the oscillator.

The tuned circuit, whether fixed (crystal) or variable (L-C), can be considered as a part of the amplifier inside the feedback loop. It serves to make the amplifier's gain variable with frequency. At the frequency to which the circuit is tuned, gain is maximum; at all other frequencies, gain is lower.

The feedback formula shows us that any feedback circuit will oscillate if feedback is positive and the gain-feedback product is greater than "1". This, in turn, shows us how feedback affects an oscillator.

If too much feedback is used the gain-feedback product will exceed "1" over a band of frequencies rather than at a single point. If not enough feedback is available, the product will never be greater than "1" and the circuit cannot oscillate. For most stable operation, the gain-feedback product should equal "1" *only* at the frequency at which output is desired. This means that control of feedback is somewhat critical.

The higher the "Q" of the tuned circuit, the greater will be the gain and the less feedback will be necessary for high stability. This is sometimes described as a "lightly coupled" tuned circuit, but either image of the process is equally correct.

Fig. 5A shows one type of oscillator circuit; we'll look at quite a few other types in a later part of this article.

Right now, let's move over to "neutralization." The major difference—in theory, at least—between a neutralized amplifier and an oscillator is the phase or "sign" of the feedback.

For example, **Fig. 5B** shows a triode rf amplifier neutralized by the "loop" method. Notice the similarity between this circuit and that of **Fig. 5A.**

Neutralization is necessary in most rf amplifiers which operate at any appreciable power level because inescapable stray feedback usually exists. Since it is not controlled, it may be either positive or negative in sign.

If it's positive, and if the amplifier has enough gain, oscillation will result.

Even if no oscillation occurs, the "regeneration" that does exist will make the amplifier's performance somewhat unpredictable. It can easily cause a "linear" to produce distortion at only one or a few specific output power levels. This means distortion may occur during only a part of a syllable, with the amplifier operating perfectly at all times. Such problems are difficult to locate and correct; neutralization of the amplifier is always a recommended first step.

A *perfectly* neutralized amplifier will have no effective feedback; all that is accidentally present has been cancelled out by that put in during the neutralization process. Most neutralized amplifiers are slightly over-neutralized. The only effect of this is a slight reduction in gain—coupled with the provision of a safety margin, should operating conditions change slightly. A badly overneutralized amplifier, though, *may* oscillate. In theory, it shouldn't but when excessive feedback of either sign is present an rf amplifier often changes its characteristics so that the sign of the feedback changes also. This is sometimes attributed to Murphy's First Law of Physics, which declares that "If anything *can* go wrong, it will!"

We mentioned in passing earlier that in some cases, the "feedback" approach might be more complicated than an alternative. **Fig. 6** shows this alterantive. **Fig. 6A** shows the actual circuit of the "bridge neutralization" idea, while the active part of the circuit appears in **Fig. 6B.**

The idea here is to account for all feedback paths as legs of a bridge circuit, and then to balance the bridge so that no path exists between the input and the output of the amplifier except that feedback-free path provided by the electron stream within the tube. Stray capacitances involved are shown as dotted-line components and leads in **Fig. 6A,** to identify their nature, and similarly in **Fig. 6B,** to show where they fit into the bridge.

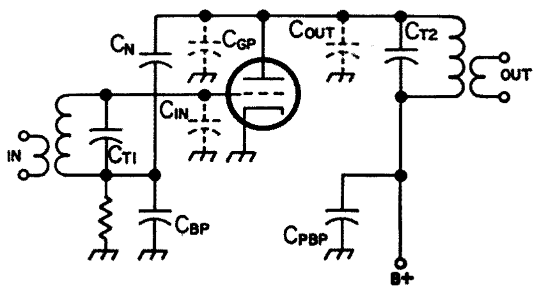
This circuit is neutralized by adjustment of the value of capacitor C_n. The great advantage of this circuit over more common means of neutralization is that it may be adjusted with full power applied, under operating conditions, since the adjustment is far removed from the high-voltage area of the amplifier. More conventional feedback approaches usually may be adjusted safely only when power is off; feedback paths change when power is applied, so they are more difficult to adjust accurately.

Even the bridge circuit, however, is a feedback affair. Note that the output is coupled to the input by *two* paths, and that these paths have opposite phase relationships. This is what balances the bridge—but it's also a feedback cancellation.

How Can CW Transmitters Be Properly Keyed? We could use twice as much space going more deeply into feedback, oscillation, and neutralization—but if we're going to cover all the questions this time, we must turn our attention to keying.

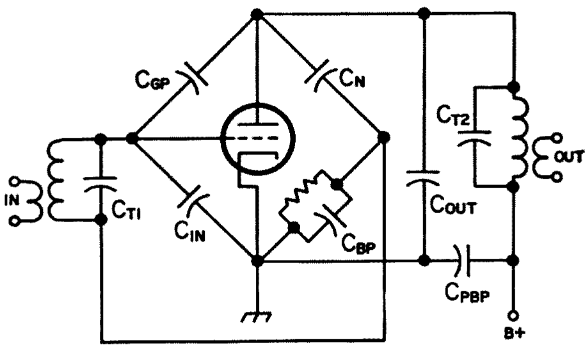
It might appear that keying of a CW transmitter is the simplest thing imaginable. All we need to do is to let the rf go out when we want a dit or a dah, and hold it in the rest of the time.

Unfortunately, it's not all that simple. The keying waveform cannot be a simple and di-



(A)

Fig. 6. "Bridge" neutralization is the most common type. Circuit A is the way it is normally drawn. Circuit B amphasizes the balanced-bridge method of operation. When ratio Cn/Cbp equals Cgp/Cin, the bridge is balanced and no output signal can get back to input. Alternate viewpoint is that negative feedback through Cn balances positive feedback through Cgp.



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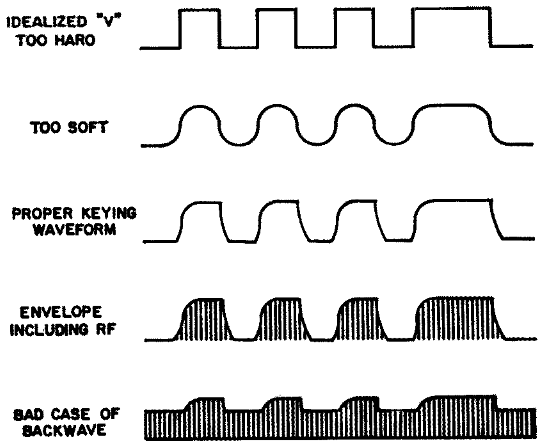


Fig. 7. Various factors in the keying of CW transmitters are illustrated here. The third and fourth lines from the top show the ideal case; the remaining three are to be avoided.

rect "make and break", because this will produce a splattering type of interference known as "key clicks". Other things can also go wrong.

Fig. 7 shows a few of the considerations involved in proper keying. All the lines in this picture represent the waveform of the letter "V", sent in CW. The top line shows the way we normally think of the character. The squared-off sharp edges, though, will produce key clicks (which are exactly the same as "splatter" or "buckshot" on the phone bands), and clicks are illegal. This waveform, then, is too "hard" for use.

If all the edges are severely rounded, as shown on the second line, we won't have any key clicks—but it may be difficult to tell when a dit or a dah ends. This keying is too "soft"; that is, it tends to run together.

The happy medium is something in between, as shown on the third line. Edges are slightly rounded, but the transitions are sharp enough to be readily distinguishable.

All three upper lines show only the keying waveform. The lower two show the actual rf output signal, both with the properly keyed waveform.

If everything is working right, you will get the output shown on the fourth line. When the key is down, maximum rf goes out. When the key is up, output is nothing at all.

Many rigs, though, suffer the ailment known as "backwave", which is shown on the bottom line. Maximum power still goes out when the key is down—but with the key up, power doesn't drop to zero. It remains at an appreciable level. We've exaggerated it here, but if even as much as 1 to 10 watts goes out (from a 1000-watt rig) that's enough backwave to be heard around the world!

Radiation of this backwave occurs because of faulty keying-circuit design, and the only cure is to bring the keying circuits up to standard. If low-power stages are keyed, then you must make sure that all stages from the keyed stage to the antenna cannot produce output when the key is up.

One of the most certain cures for backwave radiation is the installation of "full break-in" capability. This requires that the oscillator be inoperative whenever the key is up; without any rf generator in action, it's difficult to get rf radiated. There's not room here to go into the details of achieving this (and it's beyond our scope anyhow) but most of the manuals have extensive information on break-in keying.

How Can We Use Harmonics Properly? In an earlier portion of this series, we brought out that "sidebands" were not an unmentionable ailment, but were actually necessary for any communication. "Harmonics" fall into the same category. The only bed harmonics are those which we aren't controlling.

The word "harmonic" as we use it in radio refers to a "harmonic frequency", which is any frequency that is an even multiple of some other frequency.

This is, if our original frequency happens to be 3500 kHz, then the first harmonic is the starting frequency times 1, or 3500 kHz itself; the second harmonic is 3500 times 2, or 7000 kHz; the third is 3500 times 3, or 10.5 MHz; the fourth is 3500 times 4, or 14 MHz, and so forth.

The "official" textbook definition for a harmonic is "a frequency which is an integral multiple of" another frequency. The "other frequency" which we start with is known as the "fundamental", and the fundamental and the first harmonic are always the same frequency (any number times 1 equals itself!).

It doesn't take much imagination to discover that *any* frequency must be a harmonic of at least one other frequency; the mathematicians in our midst have probably already concluded that any frequency is a harmonic of an infinite number of lower frequencies. This should make it obvious that harmonics can't be *all* bad.

As we use the term, though, we usually think of our intended output frequency as the "fundamental", and the "harmonics" we speak of then are multiples of this intended output. These harmonics, since they are *not* the intended output, are usually undesirable. The Commission frowns upon them heavily; "excessive" harmonic content for legal purposes amounts to just about any harmonic radiated at levels strong enough to be detected outside your shack.

Inside a transmitter, we frequently generate harmonics deliberately. Examples include VFO's running in the 160-meter band to produce final output at 7 or 14 MHz, and the frequency-multiplier chains which make crystal control possible at VHF and UHF.

To generate these harmonics, we usually run higher-than-normal grid bias levels on the amplifier stages involved, and drive these stages rather heavily. In addition, we tune the output circuits to the frequency of the desired harmonic, rather than to the fundamental frequency at which the stage is driven.

To avoid the generation of excessive harmonics where they are not wanted, such as in final-amplifier stages of CW or AM transmitters, we can simply reverse these practices: run the minimum necessary grid bias, hold drive to the lowest level to get desired output, and take care that the output circuits are tuned to fundamental rather than harmonic frequency.

These three simple precautions frequently are all that are necessary to control harmonics. Occasionally, though, even more steps are necessary.

One excellent method of control is to use an antenna tuner between transmitter and antenna. This puts one or two (in some designs, three) more tuned circuits in the transmission line, and helps reject any harmonic energy which may be sneaking out.

Use of single-band dipole antennas (half-wave center-fed) provides excellent reduction of even-order (2nd, 4th, 6th, etc.) harmonics since these frequencies see very bad mismatch at the antenna. It doesn't help much against the 3rd, 5th, 7th, etc., though, since odd-order harmonics see almost as good a match as does the fundamental frequency. Fortunately, most antenna tuners do an excellent job of reducing the 3rd and higher harmonics, and if any harmonics get through one usually only the 2nd gives trouble. This means that using both a tuner and a single-band antenna will normally assure freedom from harmonics.

Low-pass filters of the TVI-prevention type are frequently used in efforts to reduce harmonics, but their effectiveness is appreciable only in the 10-meter band. Any low-pass filter which will pass 10 meters cannot reject the 2nd harmonic of 20-meter energy —and usually won't do very well at reducing 2nd harmonics on 15 meters either!

Experience has shown that most hams having trouble with too many harmonics are also having trouble in tuning their finals. A careful check on the final-amplifier tuning will go far toward eliminating the most frequent cause of citations for "excessive harmonic radiation".

How Many Types of Oscillators Are There? One of the FCC study questions—number 17 on the list—calls for a listing of "some common types" of oscillators employed in amateur equipment. To answer this one, you'll need to know the characteristics of several of the common oscillator circuits.

Any oscillator consists of an amplifier together with a positive-feedback network to permit oscillation. Additionally, any oscillator used to generate rf at a fixed frequency contains a tuned circuit or "resonator" to control the frequency of oscillation.

Either an L-C circuit or a quartz crystal may be used for frequency control. The two are equivalent in their action, but the crystal is much more precise (and much less easy to vary in frequency rapidly). Most of the common oscillator circuits come in either VFO or crystal varieties.

The feedback network may be located almost anywhere in the circuit, so long as it manages to couple a part of the output back to the input. It may be in the plate circuit (Armstrong, TPTG), in the grid circuit, or in the cathode (Colpitts, Hartley).

Figs. 8 through 12 shows some of the more common rf oscillators used in amateur equipment. In each of these, the feedback network is indicated by heavy lines. While all are shown with link-coupled output from the resonators, in practice many other types of output coupling are possible. We'll go into this in a little more detail after we examine the features of the various types.

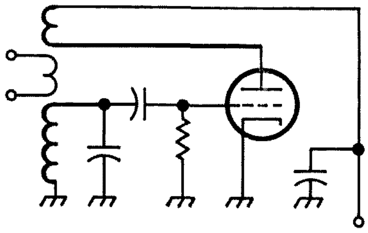


Fig. 8. Armstrong oscillator; feedback is via "tickler" coil.

Fig. 8 shows the circuit known as the Armstrong oscillator, which places the resonator in the grid circuit and couples the output back through a link or "tickler coil" directly to the resonator. This was the original oscillator circuit, but is now used only in receiver circuits if at all.

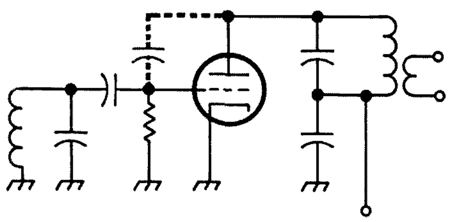


Fig. 9. Tuned-plate tuned-grid oscillator has feedback through grid-plate capacitance of tube.

Fig. 9 shows the "tuned plate tuned grid" circuit, with separate resonators in the grid and plate circuits. The feedback path here is through the tube itself; the circuit is identical to a triode amplifier *without* neutralization. To oscillate, the plate circuit must be tuned to a frequency slightly different from that of the grid. Stability isn't the best; the circuit is now used only seldom in this form.

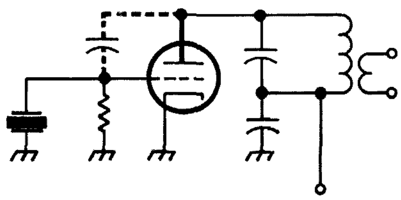


Fig. 10. Miller crystal oscillator is simply a crystal version of TPTG circuit (Fig. 9.), with crystal replacing grid tank circuit.

It does, howevr, lead directly to the Miller crystal oscillator circuit of **Fig. 10**; the only difference is that a crystal is used as the grid resonator. This circuit is extremely stable and is widely used at all HF and VHF frequencies.

Fig. 11 shows the Hartley circuit; its identifying characteristic is the tapped resonator which provides feedback by means of the cathode circuit. This circuit is widely used in receivers, and to a smaller extent in transmitters.

Fig. 12 shows what is probably the most widely used oscillator circuit now in existence; it goes under three different names, which identify the three variants shown as "A", "B", and "C".

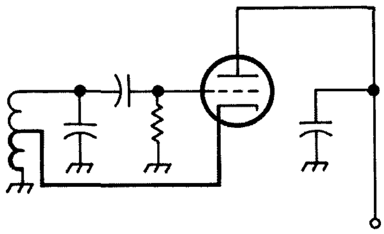


Fig. 11. The Hartley oscillator can always be identified by cathode tap on coil.

Differences in the three are exclusively in the resonator arrangements. The circuit at A is known as the Colpitts oscillator; it features a high-capacitance, low-inductance resonator, and can be designed for exceptionally precise tuning. That at B is called the Clapp oscillator; its resonator is high-inductance, low-capacitance, and is series-tuned rather than parallel-tuned. It has good frequency

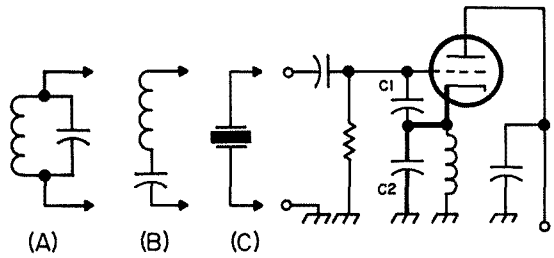


Fig. 12. Capacitance feedback circuit goes under various names, depending on the tuned-circuit arrangement. See Text.

stability but covers a wide tuning range with very small changes of capacitance.

When a crystal is used as the resonator, the circuit at C results. It is known variously as the grid-plate circuit and as the crystal Colpitts circuit.

All three obtain their feedback from the voltage divider composed of capacitors CI and C2 in the grid-cathode circuit. Effectively the circuit is identical to the Hartley arrangement, but the feedback is easier to adjust since C2 can be a trimmer capacitor, adjusted for best operation in any given layout and conditions. This capacitance voltage divider is one of the identifying features of this group of circuits; the resonator differences are the other, which distinguishes which member of the group is being shown.

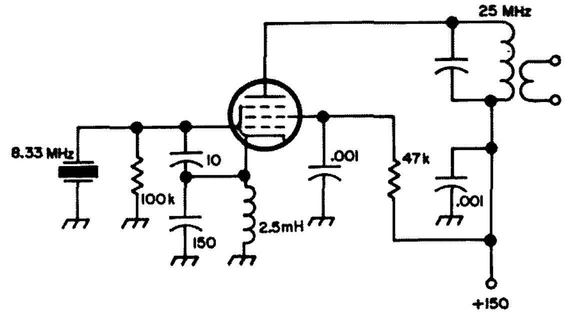


Fig. 13. Typical circuit of electron-coupled oscillator. Screen grid serves as "plate" in crystal Colpitts circuit here, while output is taken from the actual plate. Values shown are suitable for use from 7 through 9 MHz, for output from 7 through 36 MHz.

All of these circuits are illustrated with triode tubes. Any of them, however, can be made "electron-coupled" by treating the screen grid of the tetrode or a pentode as the triode plate shown in these illustrations. Output can then be taken from the actual plate, with little effect upon oscillator operation. **Fig. 13** shows a crystal Colpitts oscillator connected in this manner. The tuned circuit in the plate is adjusted for output at the third harmonic of the crystal frequency. This circuit is ideal for getting 25-MHz output from 8.3 MHz crystals, for 50-MHz transmitters.

This brief listing doesn't by any means exhaust the list of possible oscillator circuits. Almost any means of getting feedback around an amplifier can be, and has been, used. One example is shown in **Fig 14.**

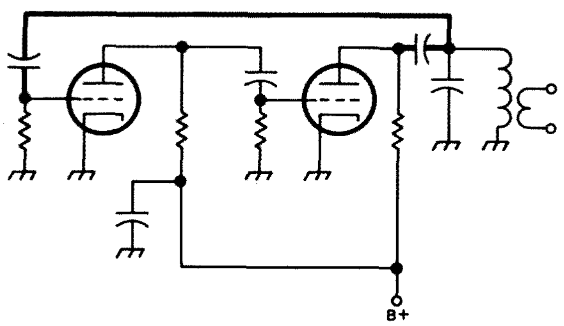


Fig. 14. Franklin two-tube oscillator circuit uses extremely small coupling capacitors to eliminate frequency drifts. This circuit, if well made with solid construction, can outperform most crystal oscillators. Output, however, is exceptionally low.

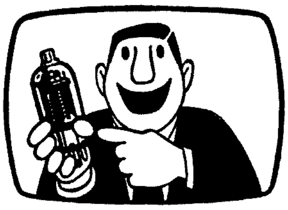
This is known as the "Franklin" oscillator; it consists of not one but two stages of amplification, connected in a loop which provides virtually total feedback. In fact, if the resonator were not connected, this would act as a multivibrator rather than as an rf oscillator.

The two capacitors which couple to the resonator are very small. One pF is a typical value for each. The resonator effectively shorts out all energy except that at the frequency to which it is tuned, and the net result is a very low actual feedback fraction —just enough to permit oscillation.

Output is very low, several stages of buffer amplification are necessary before the circuit's output can be used for any purpose.

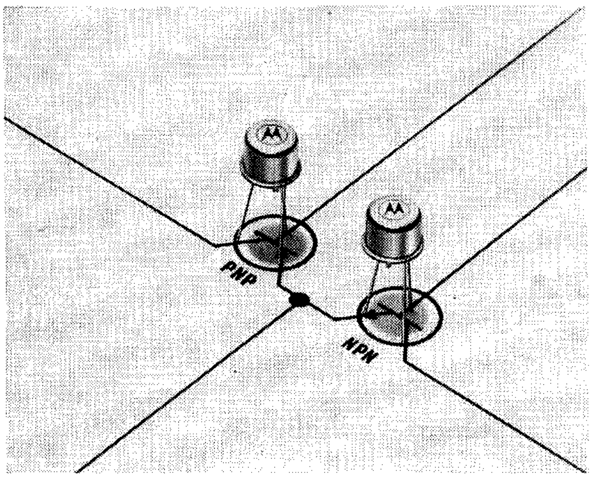
The only advantage of this circuit is that it is a VFO which is *more* stable than most crystals. Drift is almost undetectable in a well-built Franklin oscillator. Much more circuitry is needed to do this, however, and so the circuit has not gained popularity. The circuits shown in **Fig. 8** through **13** should be sufficient to permit perfect scores on this portion of the license examinations.

Next Installment. This has been an overlength installment because of the material on oscillation and neutralization. Next time out we'll attempt to even the scales by forgetting transmitter design for a while, and looking at the problems of antennas and transmission lines. Until then, good DX and happy studying. ■



NEW PRODUCTS

Motorola PNP VHF/UHF Transistor



The first silicon PNP large signal VHF/UHF power transistor available to the electronics industry is announced by Motorola Semiconductor Products, Inc. The 2N5160 was designed as the PNP complement of the NPN 2N3866 for use in PNP/NPN complementary circuit configurations such as VHF and UHF amplifiers. RF amplifier designs which must be accomplished with positive ground supply voltage will be able to keep the rf ground at the same level as the dc ground, thus eliminating by-pass problems.

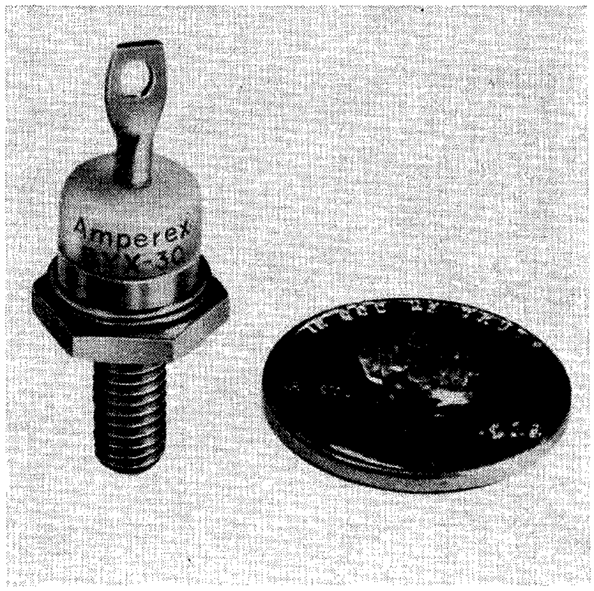
Further information and complete specifications are available from Motorola Semiconductor Products Inc., P.O. Box 13408, Phoenix, Arizona 85002.

FET Applications Handbook

While this book is heady stuff for the average amateur, engineers working with transistors will find it a must book. The $12.95 price tag is professional too. It is hardbound, has 288 pages and 225 illustrations, mostly circuit diagrams. It covers FET oscillators, linear applications, chopper and switching circuits, integrated circuits and photo-FET's. It is published by Tab Books and is available from most good parts distributors.

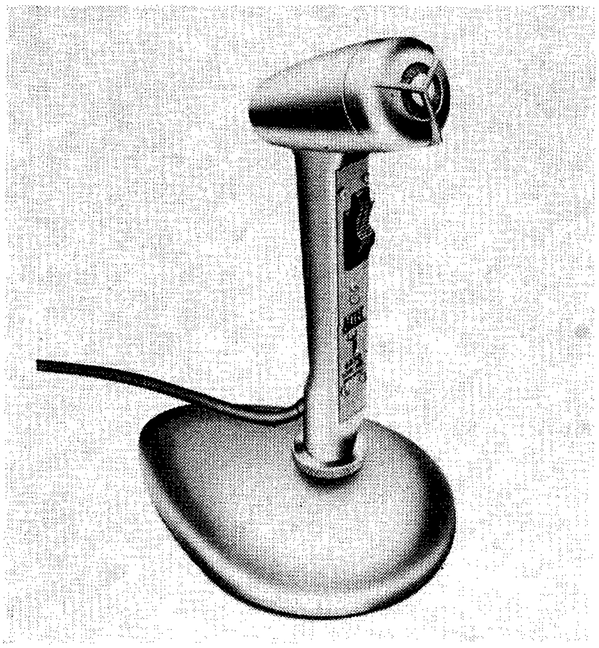
Amperex Fast Recovery Silicon Rectifier Diodes

A new series of power rectifying diodes, designated BYX-30, is now available from Amperex Electronic Corporation for use in fast switching applications such as high frequency power supplies, thyristor inverters, and multi-phase power rectification circuits. With working voltages from 200 to 600 V, the BYX-30 series offers switching speeds up to 200 amperes per microsecond at frequencies as high as 50,000 Hz with minimum power loss due to reverse recovery. Average forward current capability for the series is 14 amperes. Controlled-avalanche characteristics for the 200 Volt unit are 250 volts minimum breakdown and 515 volts maximum. For the 600 volt unit, the minimum and maximum breakdown values are specified as 750 and 1050 volts respectively.



Given specified avalanche breakdown characteristics, the designer can optimize or eliminate transient-suppression networks and can employ smaller safety factors than would be needed with less completely specified diodes.

Complete specs and applications data may be obtained by writing to Amperex Electronic Corp., Semiconductor and Receiving Tube Division, Slatersville, Rhode Island, 02876.



Altec 687B Microphone

This is a rugged moving coil dynamic microphone tailored to amateur requirements. The Altec 687B provides a continuously variable low frequency response characteristic. It permits reduction of unwanted interference while maintaining excellent speech reproduction without masking or distortion caused by low frequency overloading of the audio stages by the unique method of rotating a shutter on the rear of the housing.

The price is $42.00 and further information may be obtained by asking for data sheet AL-1478-2 from the advertising department, Altec Lansing, 1515 South Manchester Ave., Anaheim, Calif. 92803.

Ameco License Guides

Long recognized as the leader in Amateur Radio Theory course material, AMECO has come out with two new license guides for the Advanced Class and the Extra Class exams. They contain the FCC questions and easy to understand answers, with FCC type multiple choice practice exam. The guide for the Advanced License is 50¢ and for the Extra, 75¢. These two excellent guides are available now at your radio distributors. In addition, there will soon be a 33⅓ RPM record for code practice to permit the ham to prepare for the increased code speed requirement for the Extra-Class exam.

Car Call Letter Sign

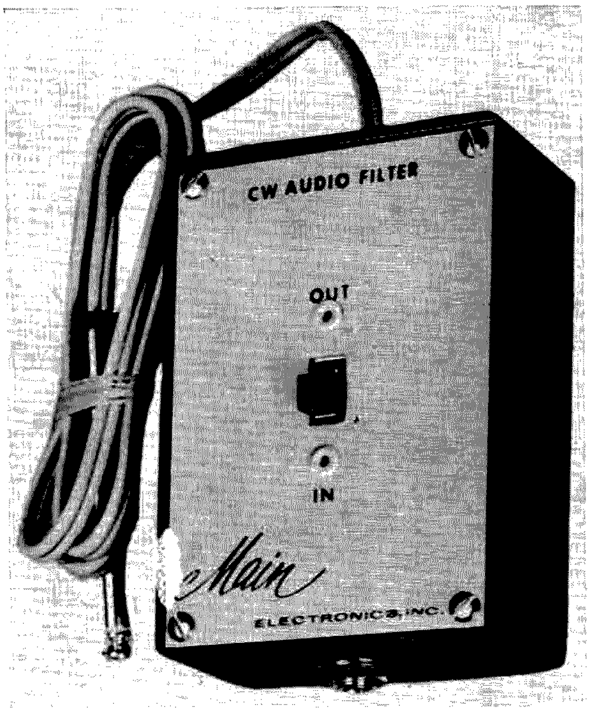
Many of us are reluctant to put a permanent call letter sign on our cars. It may be that we use the car for business, or that it is also driven by other members of the family. Also there might be just a bit of hesitation about drilling those so permanent holes in the car door or trunk.

Dymond Electronics has come up with a slick answer to this whole problem. The call letter sign is plenty big enough to really stand out and be seen by passing hams. It is 21" long by 6" high and is made of brilliant white plastic with bright red call letters that are raised about a half inch. And best of all, this sign has strip magnets all around it so that it will stick to your car even at speeds over 90 mph. It doesn't come off unless you pry it off.

This certainly seems like a great answer to having your call on your car for club meetings, hamfests and vacations.

The price is $7 postpaid from Dymond Electronics, 515 Blackstone, Fresno, CA. 93701.

The Model TS-4 Tenna Switch is an inexpensive remote switching system which allows up to four separate, remotely located, antennas to be fed from a transmit/receive site through a single transmission line. It is ideally suited for remotely switching between 3 or 4 bands of a multi-band cubical quad antenna. Both sides of the transmission line are switched, affording complete isolation and offering a decided advantage over the "Co-Ax Relay" type of remote system which switches only one side of the line. The TS-4 uses 2 low loss ceramic switch decks to perform the dual switching function. It operates on 115 VAC and employs an 18 V step-down transformer which draws current only during the short switching cycle. The system requires only lightweight control cable (4 wire cable to switch 3 bands; 5 wire cable to switch 4 bands). A single Co-Ax or Balanced transmission line connects the remote unit to the transmit/receive system. Separate short sections of either Co-Ax or Balanced transmission line connect up to 4 individual antennas or driven elements of a quad into the remote unit, mounted on the boom, mast or tower. The switch is capable of handling inputs of 2 KW PEP or 1 KW AM-CW. The Tenna Switch is manufactured and distributed by Cubex Company, Box 732, Altadena, CA 91001, and sells for $15.95 at dealers or direct PPD USA.



Main Electronics CWF-1

If you are irritated by the QRM level on the CW bands these days, this new device will be of interest to you.

A new CW audio filter with high selectivity is being marketed by Main Electronics, Inc.

Called the CWF-1, the unit offers very high selectivity for the reception of CW on all transceivers and receivers which many times have deficiencies in this mode.

The "Black Box" is merely plugged into the 2 to 4 ohm audio output of a receiver and headphones plugged into the CWF-1. It has a switch for taking the filter in or out of the circuit as interference dictates.

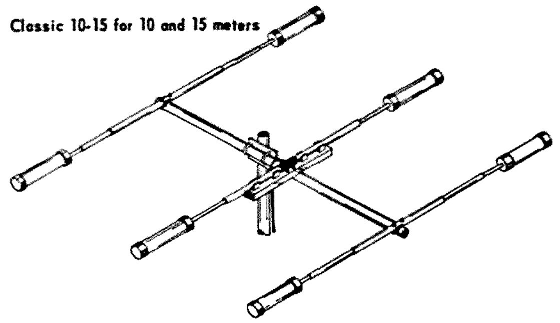
The selectivity is 120 cycles wide at the 6 dB points and 200 cycles wide at the 10 dB points. This is achieved by the use of high-Q toroidial inductors in a four pole filter circuit. The output is designed to match 2000 ohm headphones.

The filter not only separates the wanted signals out of the QRM, but also improves the signal-to-noise ratio when receiving weak CW signals close to the noise level such as in VHF DX work.

The device measures 2⅝ inches wide, 1⅝ inches high, and 4 inches deep.

A descriptive brochure is available upon request. The price is $19.95 postpaid from Main Electronics, Inc., 353 Pattie, Wichita, Kansas 67211.

Classic 10-15 for 10 and 15 meters



Two New Beams from Mosley

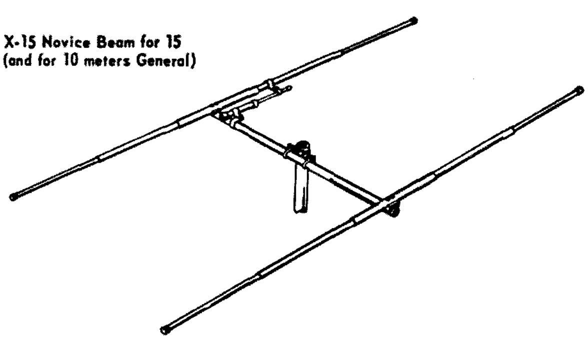
Mosley has announced two new antennas. One a duo-band 10/15 meter beam to take advantage of the openings on these bands which are now improving; and a single band 15 meter beam for the Novice.

The Classic 10-15 has a maximum front-to-back and a forward gain of 8 dB compared to reference dipole. It is power rated for 1 KW AM/CW, and 2 KW PEP SSB input to the final. This antenna has a maximum element length of 9′ 10″, a boom length of 12′, and a turning radius of 11′ 7″. It will withstand a wind load of 110 pounds (EIA standard at 80 MPH) Shipping weight is approximately 32½ pounds.

The X-15 is a two element, easily constructed antenna with a forward gain of 5 dB with a 20 dB front-to-back ratio. It is full power rated up to legal limit. Maximum element length is 22½′. Assembled weight is approximately 13 pounds. Shipping weight about 16 pounds.

Further information is available from Mosley Electronics Inc., 4610 N. Lindberg Blvd., Bridgeton, Missouri 63042.

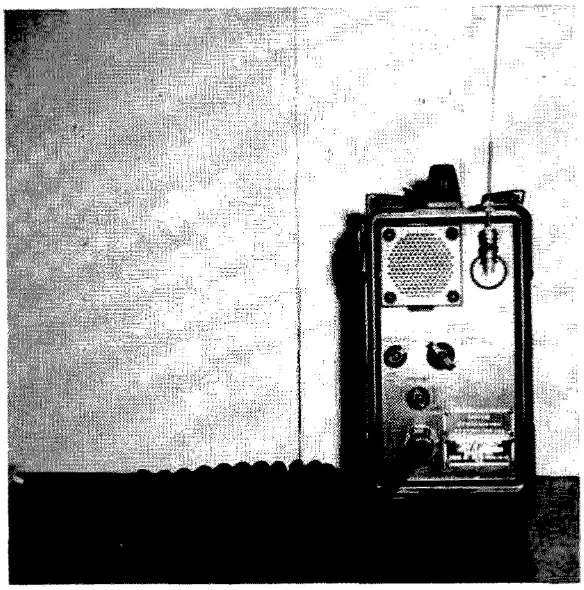
X-15 Novice Beam for 15 (and for 10 meters General)



Continued on page 134

Putting The RT-209/PRC on Two Meter FM

Joe Owings KØAHD
10217 St. Daniel Lane
St. Ann, Mo. 63074



Recently a number of RT-209/PCR Walkie Talkie sets have appeared thru U.S.A.F. MARS programs. With a not too complex job of conversion these make nice units for the two meter FM frequencies. This equipment is also known as Radio Set AN/PRC-21 and operates on a single crystal controlled frequency in the 152-174 MHz range. Most of the units I have seen were set up in the 160 MHz range.

The receiver uses a non-oven crystal unit CR-23/U and the crystal formula is:

$$\text{xtal freq.} = \frac{\text{operating freq.} + 2.5 \text{ MHz}}{5}$$

This is a small hermetically sealed crystal unit like the HC-6/U and is available from most manufacturers. The transmitter uses a non-oven crystal unit CR-18/U (also similar to the HC-6/U) and to select the desired crystal frequency, the formula is:

xtal freq. x 32 = carrier freq.

In first looking at the RT-209, you will notice that there are four trunk type fasteners on the top and the bottom of the case. The two rear ones on the top and the bottom are for access to the battery compartment. The front four are for removing the receiver-transmitter unit from the case. This set has an internal loudspeaker and the audio connector on the front is for an H-33/PT type handset, a type common to military mobile equipment. This handset also contains the push-to-talk switch. In opening the front door of the unit, you will see that there is a main chassis frame containing individual circuit modules by stages. Basically, the modules on the outside edge house the transmitter and the inside modules house the receiver.

Transmitter Modification

1. Remote Z201 (XMTR-OSC) from the frame and place a 2.7 pf capacitor across the coil terminals. Use a Grid Dipper to resonate the circuit to approximately 4.5 MHz and re-install in the frame.
2. Pass up Z202 (MODULATOR), no modification necessary.
3 Remove Z203 (1st DOUBLER), Z204 (2nd DOUBLER), Z205 (3rd DOUBLER), Z206 (4th DOUBLER) in that order and place a 2.7 pf capacitor across their respective coil terminals. Grid Dip the modified coils to near the proper frequency for each–Z203 (9 MHz), Z204 (18 MHz), Z205 (36 MHz), and Z206 (72 MHz). In replacing the modules in the frame, check the numbers on each as it is replaced to make sure it is in the right place. When properly installed, the test point tab on each module will be oriented to the outside edge of the frame.
4 Remove Z207 (5th DOUBLER-XMTR PWR AMPL) from the frame. In looking at it you will see that the coil for the 5th DOUBLER is a wide-spaced, 4 turn coil and it is this coil that must be removed from the module. Unsolder both wires from it, noting that the blue

wire goes to the end of the winding nearest the mounting lug, and unsnap the spring mounting clip removing the coil from the module. Using a small screwdriver, scrape the varnish from between and holding the coil turns carefully, and compress the coil so that it is close-wound at the bottom end of the form, spaced about wire diameter.

5. Replace the modified 5th DOUBLER coil in the module, resoldering the wires as originally connected. Place a 2.7 pf capacitor across the coil terminals and grid dip the coil to about 146 MHz.
6. Look at the other coil in the module which is the final tank coil. It has a plate winding with a one turn link for the Antenna which is woumd over the P.A. coil. Here there seems to be a difference in some units I have seen as on some the top two turns are wide-spaced and in some, they are close-spaced. If the top turns are wide, carefully take a screwdriver and compress them so that the coil is spaced about wire diameter. This may be accomplished satisfactorily without removing the coil from the module. Look at the coil terminals on the bottom of the coil and you will see that one side of the ANT. link is grounded with the other end connected to a white wire. The Plate winding is the other two terminals across which you should connect a 2.7 pf capacitor. Replace the module in the frame. Modification is complete.

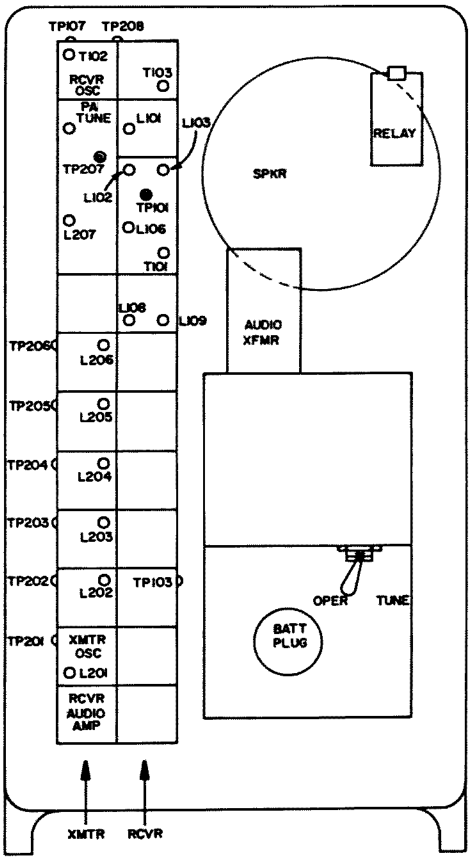
Transmitter Tune Up

1. Tume up is done with a vacuum tube-voltmeter on the lowest dc voltage scale. A 10 megohm resistor is connected in series with the negative probe with the positive connected to the chassis frame. The probe (w/resistor) is connected to test points TP201 thru TP207 as the transmitter is keyed and in that order each stage is peaked for maximum indication at its associated test point. The PWR AMPL test point (TP208) is located on the top end of the chassis frame and is peaked with an antenna attached while tuning the final stage.

Receiver Alignment

It will be assumed that the *if* amplifiers are relatively well aligned so no adjustment will be attempted on these stages. This type alignment would considerably complicate the job.

1. Install a crystal for the desired receive frequency and with the vtvm and 10 megohm resistor previously prepared for tuning the transmitter. Connect the probe to TP107 which is located on the top end of the chassis frame. Turn the set on in the HANDSET position. Adjust T102 (RCVR OSC) slug for maximum indication on the meter then continue to turn the slug counter-clockwise until approximately 0.8 of the maximum indication is obtained.
2. Connect the vtvm (with resistor connected) to TP101 and adjust T103 and T101 for maximum indication.



Tuning slug locations

3. Connect the vtvm (with resistor connected) to TP107. Adjust L109 until a small dip is noted in the reading, then turn L109 about one turn clockwise past the center of the dip.
4. Connect the vtvm to TP104 and adjust L108 and L106 for maximum indication.

At this point in the alignment a signal on the desired receive frequency is necessary, either from an accurate signal generator or a transmitter known to be on frequency. If a

signal generator is used, connect it directly to the ANTENNA connector; if a transmitter is used, place it near but do *not* connect to the unit.

6. Tune (in this order) L106, L108, L106, L103, L102, and L101 for maximum indication with the vtvm connected to TP103.

This completes the receiver alignment of the unit. Again the *if* alignment is not attempted. Replace the transmitter-receiver unit in the case and the battery in the rear compartment and your unit is ready to go. The unit used here is set up on the St. Louis Repeater frequency which is 146.34 MHz transmit and 146.94 MHz receive. Don't have any grand illusions about a real powerhouse unit as the RT-209 is rated by the military at a tremendous 150 milliwatt output. This may seem extremely small, but it is more than I presently get out of a surplus battery of unknown age and I can work thru the St. Louis Repeater with it on an 18 inch whip connected to the ANTENNA connector from my basement, which is about five miles from the Repeater.

One word about the battery this unit uses. It may be rather a hard item to come by in good condition. The voltages supplied are 1½ volt, −6 volts, 45 volts, 67½ volts, and 135 volts. The military FSN is 6135-577-3340 and the nomenclature is Dry Battery type BA-358/U. The ones I have seen are manufactured by the Marathon Battery Company of Wausau, Wisconsin. The advailability of them thru non-military channels is unknown. The applicable Military Tech Manual is TO31R2-2PRC21-11. The manufacturer of all that I have seen is Motorola, Inc.

. . . KØAHD

Coiled Cords Untangle Test Leads

Conventional test leads, as supplied with test equipment are usually several feet long and have an annoying habit of getting tangled up with other things on the work bench.

A simple way of keeping your leads untangled is to use "coiled cord" for test lead wire. When not in use, this cord retracts to only a few inches and stays out of the way. Belden makes special coiled test lead wire (#8878-9). It is available either with or without test prods.

You will be pleasantly surprised at how much time you will save by using coiled cord.

D. E. Hausman VE3BUE

250 Sockets

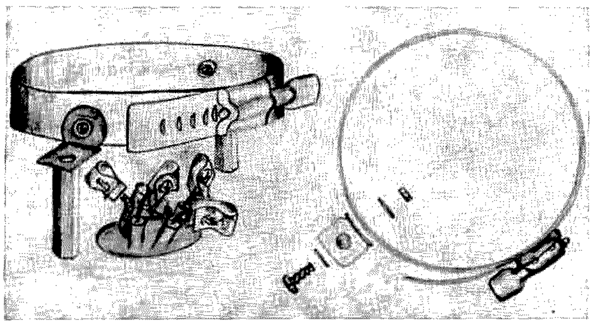
4-125, 250 and 400's can be picked up at very reasonable prices on the surplus market. Many are available through the various MARS programs. At such low cost, many fellows have put a few of these tubes away, contemplating a higher power rig, only later to lose interest after pricing their not-so-inexpensive sockets. If you're one of these individuals, take heart; this might help move that dream a step closer.

Here is a socket designed from a circular hose clamp which adjusts to the size of the tube base (about 3" in diameter). Two holes are drilled on opposite sides of the clamp and two pieces of stiff sheet metal (old tin can) fashioned as brackets. These brackets are fastened to the clamp with small screws and washers. The clamp assembly is then mounted about an inch above the chassis on metal standoffs.

Connections to the tube pins are made with Fahnstock clips soldered to the wiring going to the socket. Be sure to use insulated sleeving on the wiring passing through the chassis to the socket.

To seat the tube, first carefully attach the clips to the base pins. Dress the leads neatly and check to see that none are shorting to each other or the chassis. Then position the tube so that the small nuts on the inside of the clamp fit into two of the ventilating holes in the ring around the base. With the tightening of the thumb screw, the socket is complete. A small blower will take care of the cooling since the tube base is elevated, well exposed in the air stream, with the clamp and metal standoffs providing excellent heat sinks.

The following "socket" has been used in a six meter amplifier with a 4-250A for the past year with superb results. Total price was a rumaged junk box, although parts, if purchased, shouldn't go above a dollar fifty.

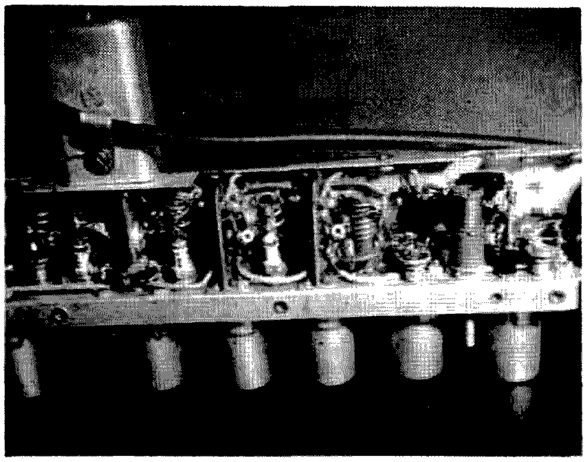


Who says high power has to be expensive?

. . . WA3AQS

Converting the ARC-1 Guard Channel for Two Meters

W. W. Davey W7CJB
329 East Kent
Missoula, Mont.



The guard channel in the ARC-1 is normally used on 121.5 MHz and in some of the older sets a frequency of 140.58 was used. These strips make an excellent two meter converter which can be made to operate into any tunable *if* system between 8.5 and 10.5 MHz.

Removing the unit

As you face the front of the ARC-1 the guard channel is a strip 11½ x 1½ inches and is on the left hand side of the unit. This strip can be easily removed by removing a few mounting screws, unsoldering 6 power connections underneath, and unsoldering the output lead from the *if* can attached to the guard channel chassis. The strip can now be pushed upward and out of the ARC-1 framework.

Testing the strip

Now is a good time to test the chassis as a converter to make sure it is working. It is very discouraging to modify some piece of gear and be unable to get it to work, only to discover that there was some defective part in it in the first place. Connect a piece of small coax on the output terminals. These are the two prongs sticking out of the *if* can at the bottom side of the chassis. This lead will go to your communication receiver antenna and ground. Facing the back or bottom of the chassis there are five feed-through condensers on the extreme right end of the chassis. This is where power must be applied. As a temporary measure three of these condensers must be grounded to make a temporary check to see if the strip is operating. The three you are going to ground normally supplied bias to the various stages. **Fig. 1** shows where to connect power into the chassis.

The unit will require 12 volts ac for the filaments and 100-150 volts dc for the plate supply at around 50 mA. If there is a 6210 kHz xtal in the socket the unit is tuned to 121.5 MHz. If there is a 7270 kHz xtal in the socket the unit is tuned to 140.58 MHz.

Most of these units are tuned to 121.5 MHz, however. If the strip is working ok it will pick up the 18th harmonic from a 6750 kHz crystal oscillator, with but a few feet of antenna on the converter. The *if* output will be 9720 kHz and can be tuned in on your communication receiver.

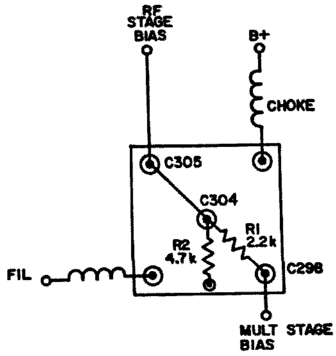


Fig. 1. Diagram of power connections to the chassis.

Procedure

If everything is working, you can now start modifying to get to 144 MHz. The oscillator chain in this strip is anything but stable since they multiplied 18 times in the second 6AK5 and then used two more 6AK5's as amplifier stages. These two 6AK5's working straight through can create a lot of havoc, so lets change this. The second 6AK5 (V126) can easily be changed so that it will tune to the 6th harmonic of the crystal, then the next stage will multiply 3 times and the last stage in the chain will be the amplifier. The oscillator chain becomes quite stable with this arrangement.

The plate coil of V126 needs to be removed. First unsolder the grid coupling condenser to V127 and the 1000 ohm plate decoupling resistor. The straps from the coil assembly to pins 5, 6 and 7 of V126 can be cut with a diagonal pliers, or unsoldered, as can the strap to pin 2 of V127. After loosening the two nuts that hold the coil assembly, the entire coil assembly can be removed from the chassis. Save these parts as you may need them for spare parts at some later date.

You are going to replace this coil assembly with a 45 MHz *if* coil from an old junk TV set or if you have no junkers around, you can buy a new Miller #6225 replacement *if* coil. Strange as it may seem these 45 MHz *if* coils will snap right into the hole in the chassis without enlarging the hole. However, prior to pressing the new coil into the hole, make the following changes. Mount a small soldering lug on the 6/40 bolt which fastens the V127 tube socket to the chassis. Now run a wire from pin 2 of V127, through the soldering lug to pin 7 of V126. This will put the necessary grounds back which were clipped off when the original coil assembly was removed. Push the 1000 ohm resistor back toward the side of the chassis and solder a wire to it—pull the wire down through pin 6 of V126, and let about an inch of wire extend from pin six. This will later be soldered to the new coil. Now then, mount the 45 MHz TV coil by pressing it into the hole in the chassis. Run a wire from pin 5 of V126 to the top terminal of the new coil and at the same time connect V127 grid coupling condenser to the top of the coil. The wire that was left hanging from pin 6 of V126 can now be connected to the bottom terminal of the TV coil. Between the bottom terminal of the TV coil, and the soldering lug, solder in a .005 ceramic condenser. These changes are shown in **Fig. 2.**

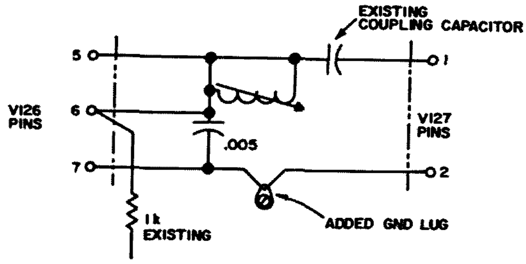


Fig. 2. Details of the modification using new *if* coil.

To get the rest of the coils down to where they will work on 144 MHz, it will be necessary to remove all of the 10 mmfd ceramics that are soldered across all of the coil assemblies. There are 6 of them. V127 plate—V128 plate—V124 grid—V124 grid—V123 plate—V123 grid, and the antenna coil. In some chassis these may be 12 mmfd. These condensers are not shown in the schematic and apparently were soldered in, depending on what frequency the guard channel was to be operated on.

Oscillator chain tune up

The crystal should be changed to a frequency of around 7450KHz to 7600KHz. Any crystal in this range will work, but the *if* output will be different. I suggest you decide approximately what 144MHz frequency you wish to listen to, then subtract 9.7 MHz from this frequency to get the output frequency of the oscillator chain. Divide the output frequency of the oscillator chain by 18 to obtain the crystal frequency. If you don't have a crystal exactly on this frequency, remember of course, that you can vary the *if* freguency between the limits of 8.5 MHz to 10.5 MHz.

We may have to resort to several tricks to get the oscillator chain tuned up. First the crystal oscillator (V-125) can be tuned by connecting a test meter on the test point right next to the crystal. Tune the crystal plate coil for maximum reading on this test point. The next stage, the coil which you have added, should be tuned roughly with a grid dipper to 45 MHz. You can then use a field strength meter coupled near the coil, or by coupling to a receiver

which will tune to 45 MHz, tune for maximum S-meter reading.

The next stage, V-127, will be a little tougher. Here you need a receiver that will tune to 133 to 135MHz or a grid dip meter or field strength meter of some sort. First spread the turns on the coil until the coil is about ⅝" long. Remember, when you tune the brass slug you reduce inductance with the slug all the way in, and that you increase inductance with the slug all the way out of the coil. If you are reaching resonance with the slug all the way in, then you have too much inductance and you must spread the turns some more. If you are approaching resonance with the slug all the way out, you need to squeeze the turns together somewhat. The plate of V-128 may be tuned in the same manner. If you are at least close to resonance on these coils you can connect a VTVM across the two test points next to V-124 and tune for maximum. At this time you can touch up all the slugs previously tuned.

RF section tune up

If the oscillator chain tuning is somewhere near correct, you can feed a 144MHz signal into the front end on about a 3 or 4 foot piece of wire, and by tuning to the correct *if* output frequency on your communication receiver you will be able to use the communication receiver S meter as an indicating device. Again spread the coils until they are about ⅝" long. The antenna coil has 4 turns and should be spread to a length of ½ inch. Check each coil, one at a time, starting with the grid of the mixer and working toward the antenna. Screw the slug in or out, and squeeze or spread the coils as necessary. As you approach optimum tuning on all coils you will be able to use a few inches of wire for an antenna, and by turning on a crystal oscillator across the room, you will be able to tune all the slugs for maximum, including the slugs in the oscillator chain. NOTE—replacing the chassis cover will change the tuning somewhat.

Free bias voltage

Now, about those three feed through condensers which we grounded at the beginning. These are supposed to have about 1.5 volts of bias on them. You can use a flashlight battery for bias, or if you want something for nothing, here is how you do it.

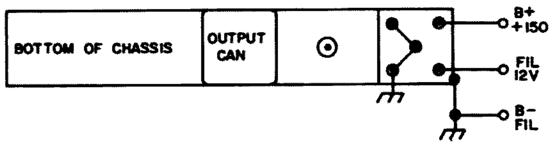


Fig. 3. End view of the chassis barrier.

Remember when you tuned the oscillator stage that you read upward of 6 to 8 volts of bias? Well—lets put it to use. Find the lower end of R-240; the 10 k resistor on the oscillator test point. Lift this resistor from the standoff type tie point and ground the resistor. The green wire which is also connected to this same tie point can now be soldered to the junction of R-240 (10 K) and R-247 (100 K) or in other words, the test point on the oscillator grid. Tracing this green wire back to the opposite end of the chassis you will find it comes to the center feed-through condenser on the barrier at the end of the chassis. There are five feed-through condensors on this barrier. Remove the three 100 K resistors and the 1500 ohm resistor located in the small compartment between the barrier and the end of the chassis. Rearrange the circuit as per **Fig. 3.** The bias voltage on the oscillator test point should be about 2.7 volts as measured with a VTVM. If it is not you can juggle the size of R2 until the desired voltage is obtained. It was found that 2.7 volts at this point gave better results than the 1.5 volts from the flashlight battery previously mentioned.

Operating Notes

The converter should be operated with 125 to 250 volts of B plus. The *if* output can should be tuned for maximum at the center of the frequency range you wish to cover. You can tune at least a 500KHz portion of the band with negligible loss of signal strength, without tuning the front end. While I have no way of actually measuring the noise figure, I did place a Nuvistor preamplifier manufactured by a well known ham supply house ahead of this converter and found that there was only about 1 dB increase in signal to noise ratio. This is hardly noticeable to the human ear. All in all I would say this is a very worthwhile 144MHz converter.

Removing the guard channel from the ARC-1 in no way affected the operation of the ARC-1 as a transceiver.

. . . W7CJB

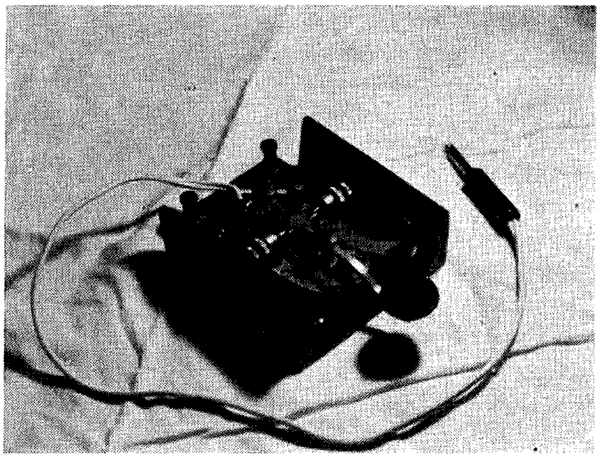
D. E. Hausman VE3BUE

Non Slip Key Base

The most annoying thing about telegraph keys, be they hand keys, bugs or paddles is their tendency to slip while being keyed. I found a cheap and easy way to make my trusty J-38 stay put. A piece of steel "U" channel, with the key bolted inside it did the trick. I got my channel from a machine shop at no cost, hence it is a bit short. Scroungers cannot be choosy! The exact size of the channel will depend on the dimensions of your key.

Although I chose to leave my base unpainted for that "rustic" look, a coat of spray paint won't hurt. To prevent the base from marring my operating table, I used some self-adhesive felt pads available at the local stationery store.

The key and base are now so heavy that it is virtually impossible for the key to take a walk around the operating table. The sides of the channel also afford a certain amount of protection from electrocution. In the J-38 at least, the shorting bar does not interfere with the side of the channel.



The non slip key base is made from a piece of scrap "U" channel. Three holes were drilled and tapped in the base for the mounting screws.

How To Use Your VOM-VTVM & Oscilloscope

Very good basic book on the use of these most common pieces of test equipment. $3.95 from Tab Books, Blue Ridge Summit, PA 17214. 190 pages.

Hybrid RTTY TU

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In W2NSD's RTTY Handbook, pages 47, 48 and 49, a silicon transistor RTTY converter (TU) is shown. The board is sold by Tri-Tronics Lab, in Euless, Texas, for $2.00 and works very well. The only exception is that the transistors are an industrial type, hard to find, expensive and the versatility of the unit is somewhat limited. So let's "Hybrid" the unit and give it a bit more versatility.

I bought the board, checked around and found I could replace transistors Q1, Q2, Q3 and Q4 with 2N697 silicon transistors which only cost 52 cents each. Q5 is replaced with an RCA 2N3440 which costs $2.06, and is well worth it. Don't be misled by over the air remarks on the little green keys that the 2N3440 won't take it and will burn out. Don't you believe it! I have had two of these units going for nearly two years and it hasn't happened yet.

Now, turn to page 49 in the W2NSD RTTY Handbook and check off terminal numbers 117, 113, 112 and 110. When the unit is wired do not connect to these terminal numbers; disregard them. For the power to the unit, use what it calls for: 12 volts dc, but for the loop dc to the keying transistor, the 2N3440, I used the K8DKC power supply, shown on pages 28 and 29 of the August 1965 QST, or as shown in **Fig. 1.**

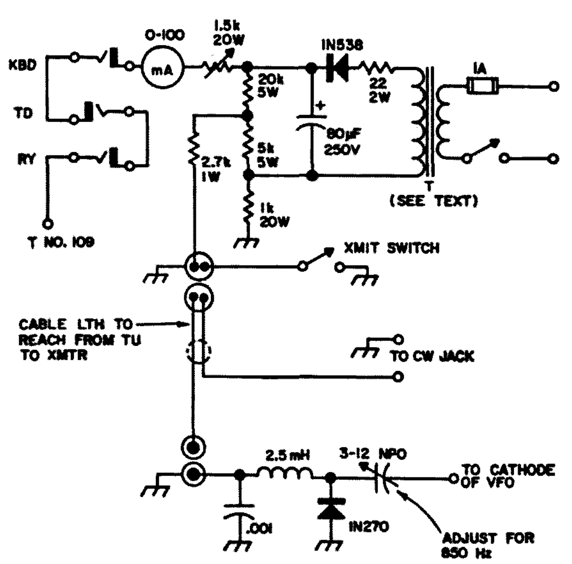

Fig. 1. "Hybrid" circuit used with Tritronics TU and K8DKC loop supply.

I used a Triad R-30 transformer for T-3. It's rated at only 50 mA, but it will give 60 without a groan. It also has a 6.3 volt ac center tapped winding at 1.5 amperes, if you need it. K8DKC used a Stancor P-8421. I have also used a Triad N-51X, an isolation transformer, rated at 130 volts dc at 300 mA. Any one of these three are ok.

Connect all parts as shown in the schematic and insulate all three keying jacks and the "B" plus from the chassis. Connect the "B" plus to terminal number 109 on the board.

Now that the terminal unit is complete and wired, plug in the transmitter distributor (TD). If you do not own a TD, use a shorted phone plug in this jack. Plug in the keyboard and the printing relay. Turn on the unit and adjust the 100,000 ohm pot connected to terminal 116, 118 and 120. Watch the 0 to 100 mA meter and stop at 60 mA. With no signal into the terminal unit time in an RTTY station and begin to copy. If you get no copy or it is garbled, reverse the switch.

When you get tired of just copying, build an FSK board and give me a call. On page 35 of the August 1965 *QST* K8DKC shows how, or see **Fig. 1.** Use a 3 circuit mike jack and a SPST switch to FSK the transmitter and to control it in the CW position. The TD, the KBD, or the incoming signal will key the transmitter. Just how versatile can one be? The total cost is less than $20.00 for the works and it's all new. Take it from me, you won't get on any easier or with so little effort, so why not give it a try? I'll be looking for you on the green keys. All comments are welcome; a SASE please, if you have any troubles.

. . . K6JFP

Using 400 Hz Transformers

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Bluff City, Tennessee

There are tons of surplus 400 Hz power transformers on the market today. Since there is not much demand for them, the price is still low. Amateurs have always sought ways to save money and still get what they need, so here is a source of untapped gold.

If you follow the principles outlined in this article, you can use high grade components in that rig of yours and still save money. Since the speech range of amateur transmitters should be restricted, the requirements for a transformer are reduced. You will find that 400 Hz power transformers are quite adequate as af output or modulation transformers.

To put one of these gems to use, you must first know a few bits of information about it. You must know its power capability and its turns ratio. Power rating is determined by multiplying the voltage and current ratings of each of the secondary is then, adding them together. This will approximately equal the primary rating. They are rated for continuous duty with high reliability, so you can push them some in amateur service. The turns ratio is easily determined from the voltage ratings. Just use the relation $\frac{E_p}{E_s} = \frac{N_p}{N_s}$ and you end up with the turns ratio. This is usually expressed as 1:1, etc. With a bit of math and a voltmeter you can put the transformers to work for you. Don't let the word math scare you. If you can multiply and divide, you can solve the math required.

I will take a typical unit and show you how to use it. The unit was built with a 125 volt primary winding tapped at 120, 115, and 110. The secondaries are rated at 5 v@ 4a and 880 v ct @ 200 mA. First, what is the power capability? 5 v @ 4 a is 20 watts and 440 v @ 200 mA is 88 w. They total 108 w. The primary must supply 108 w plus losses, so this unit would be OK at 150 watts ICAS. Now let's try the turns ratio. First the 125 v and 5 v windings: it comes out as 25:1. This is about the ratio of an audio output transformer. Then the 125 v to 880 v ratio: it is about 7:1. This is not of much use as is but I'll show later how it can be used.

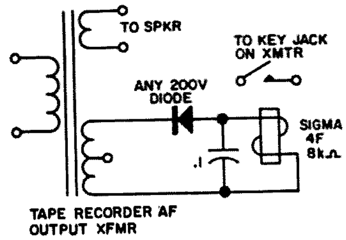

Fig. 1. Using 400 Hz surplus power transformer as an audio output transformer, complete with CW keyer for a tape recorder. Replace speaker with 8 ohm 5 watt resistor for silent operation.

Now we will see how we can use it as an af output transformer. The 5 v winding can handle 4 amps so must be made of heavy wire. If we hook a 8 ohm speaker to it, what will the load be that is reflected to the primary? Referring to the handbook we find this formula: $Z_p = Z_s N^2$. This says that the primary Z (impedance) is equal to the secondary Z times the turns ratio (N) squared. Using the 8 ohm speaker as Z_s and 25:1 as N we arrive at 5k ohms. Looking in the tube tables, we find some tubes that need a 5k ohm plate load resistance. One is the 6AQ5. It is rated at 4.5 watts. The 6BQ5 also will do and it is capable of 17 watts. This is just an example. You could use any value of speaker and find the reflected Z_p. Also, the use of the primary taps will give you ratios of 24:1, 23:1, and 22:1. This will give even wider choice of tubes. If the Z_p and Z_s are within 10% things will be fine. The high voltage winding can be used to operate a relay for automatic CW if it is the output stage of a tape recorder. Just use a silicon diode to rectify the af voltage across it and use this voltage to operate a relay such as the Sigma 4F. We are not working the transformer too hard in this use, so it should last forever.

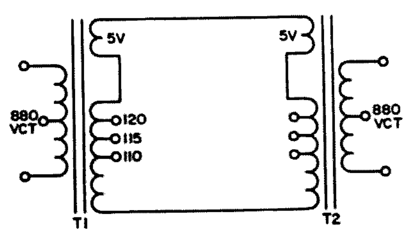

Fig. 2. Hookup for 1:1 or 2:1 ratio.

Now let's take advantage of the power capability of the transformer. If we connect two of them together as shown in **Fig. 2** we can use them as modulation transformers. To make things simpler lets look at them as one unit. The N of both units is equal to the separate N's multiplied together. The total

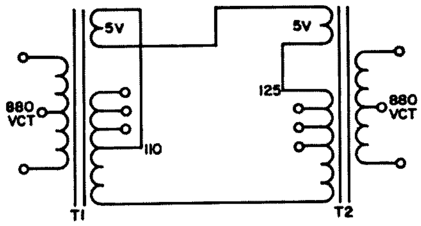

Fig. 3. Using power transformer as a modulation transformer. Ratios of 0.81:1 and 1.6:1.

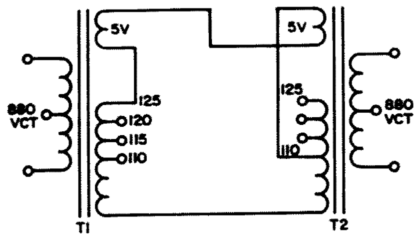

Fig. 4. 1.24:1 and 2.48:1 modulation transformer ratio arrangement.

N will be $\frac{7}{1} \times \frac{1}{7} = \frac{1}{1}$ If we choose to use half of T2's 880 v winding, the ratio is 2:1.

Fig. 3 shows how to use the primary taps and the 5 v winding to adjust the turns ratio over a wide range. Proper phasing of the 5 v winding can raise the primary to 130 v or Lower it to 105 v. The turns ratio of **Fig. 3** is: $\frac{880}{130} \times \frac{105}{880} = .81:1$ when the entire secondary if T2 is used, or $\frac{880}{130} \times \frac{105}{440} = 1.6:1$ if just half of it is used. **Fig. 4** shows another hook up. The ratios in this case are 1.24:1 and 2.48:1. You can see the other possibilities.

Transformer losses will be less than 10% as a rule if the resistance of the winding, as measured with an ohmmeter, is 1/20 of the working impedance. You should have good results if you don't try to get too much out of the transformers and hold the current in the secondary to a value that won't melt the windings. You should be able to modulate anything in the 1-200 watt class with ease. One final reminder: make sure the voltage rating is high enough. . . . W4VBH

A Plague in Your Panel

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No doubt about it, there is still plenty of World War II surplus electronic gear still kicking around, and in all probability you have some of it. So, naturally, you have long ago converted it whether it needed it or not, and in the modification process there were a few holes in the panel that were no longer needed. If you are one of the new comers to this game of radio who doesn't have any WW II surplus the normal course of events will lead you to modify some commercial or homemade piece of equipment, and guess what, some of those same types of holes will no doubt show up. When they do appear, they plague us until we can cover them. Don't fret, the plague can be arrested. There is an easy way which takes very little time and effort and results in a panel with a very pleasing appearance.

Let's assume we have a panel that has a few bolt holes about 1/16" to 3/16" in size, plus some 7/16" switch holes and even a 2" hole that used to house a meter or a power plug. The first thing to do to correct the situation is to remove the panel from the chassis. Usually it can be done with little work. There were a few types of gear built with the front panel and chassis as one unit. If this is the case, you can still improve the appearance of the panel if care is taken.

If possible, take the panel to the paint store to match it with the new spray can paint you are going to use. A word of warning regarding spray can paint; when buying more than one can of the same color (and make sure it is from the same manufacturer) check the bottom of the cans and match up the "batch" numbers. Even though the paint is produced by the same company and is supposed to be the same color, one mix or batch could be of a slightly different hue. If no batch numbers are on the cans, stay away from it—try a different brand of paint.

Next, and before removing the old paint with paint remover, copy the decals or lettering on the panel, if raised metal lettering is not used.

If you have a set with the one piece chassis/panel combination, apply the remover sparingly so as not to get it into or on the components which are mounted on the chassis. Of course with this type of panel it will be necessary to remove all the parts which can be removed. A large plastic bag can sometimes be slipped over the chassis part and taped shut. After the surface paint has been removed use a drill a little larger than the hole to be plugged, and run it through the hole to remove the last of the paint. On larger holes use a knife or sandpaper wrapped around a dowel stick. If any of the holes to be patched have raised lettering which should be removed, this can be done by using a fine grit grinding wheel in a hand electric drill.

Basically, what we are going to do is plug up the holes with automobile body epoxy filler. It doesn't matter whether the panel is of aluminum or steel. Although solder could be used on the smaller holes in a steel panel it is not recommended as the flux could cause blistering in the new paint.

On the small bolt holes, use a counter-sink bit or a drill several sizes larger than the hole and form a shallow "V" or bevel, on both sides of the panel. **See Fig. 1.** If you don't have a drill large enough, use a rat-tail or half-round file to form the bevel. On the larger holes, from about ¾" up, a different approach has to be used. First bevel the hole on the front of the panel, then cut out a piece of metal, aluminum or steel, about ½" larger in size and glue this to the back of the panel, covering the hole, with epoxy resin cement and clamp it tight. The thickness of the metal depends on the size of the hole to be covered, but usually about #18 gauge (or thin chassis stock) is usable. Needless to say, this piece of metal should also be free from grease and paint. Before cementing the metal in place, drill a few small holes in it with a #28 drill. Space the holes so that the panel doesn't cover any of them when the plate is mounted. About four or five holes will do for a 2" plate. The larger the plate the more holes will have to be drilled. **(Figs. 2 and 3)**

After allowing the backing plate glue to dry overnight, lay the panel on a flat surface, face up, with waxed paper under it. It will be necessary to shim up under the waxed paper and the panel with scraps of

metal the same thickness as the backing plate if one is being used. If you can do so, fasten the panel down to the flat surface by using small screws or brads through holes that *will* be used. This is to keep the panel from sliding about. Make sure that the heads of the screws or brads are below the surface of the panel.

Next mix up some of the epoxy filler. If you are working inside a well heated room us a little less of the hardener than the amount specified in the instructions on the can, otherwise the mix will "set-up" too fast. Apply the mix with a flexible bladed putty knife and work the filler into the smaller holes so that it squeezes into the back beveled area. Allow a little of the excess filler to remain on the front of the panel as it will shring slightly. If any raised lettering was ground off, cover the area with filler. In patching the larger holes which use a backing plate, allow some of the filler to feed through the holes in the plate. This will lock the filler in place.

After the filler has dried, remove the panel and again place on a flat surface, but face down. Use a sanding block and aluminum oxide paper to smooth the back of the panel. Start with #100 paper and finish with #180 paper. An aluminum panel can be given an even finer finish by using #0000 steel wool after the #180 grit paper is used. During the sanding, allow a little of the mix that worked it way through the holes in the backing plate to remain. The author found that it works best if the sanding block is at least longer in length than the largest hole, and sand the area so that the block covers the hole in each sweep over the area. Turn the panel over and repeat the same process on the front, using even more care to insure a smooth and mirror like finish.

The panel should now be washed in soap and water and given a final bath in vinegar. Wear cotton or plastic gloves when doing this to prevent body acids and oils from getting on the surface of the panel. When dry, place face down and spray first with a primer coat and then the regular paint. A final coat of clear spray is desirable. When the final back coat of paint is dry, turn the panel face up with a backing of an old rag or waxed paper to keep it from becoming scratched. If the panel has raised lettering do not apply the clear spray until the new paint has been scraped off the lettering, with a razor blade. If there is no raised lettering, apply new decals before the clear spray is used. Several times when renewing a panel as described, I found that I could not get the new spray paint to exactly match the old paint, so also resprayed the cabinet. Sometimes a two-tone effect between panel and cabinet is pleasing. As was said earlier, with a little time and effort that old piece of "junk" can be made to look quite nice. Try it. . . . W3RZD

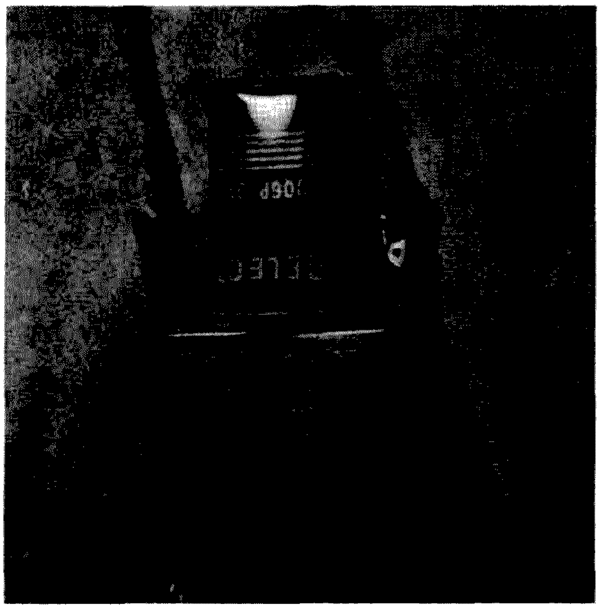
High Voltage Battery

D. E. Hausman VE3BUE

Have you ever needed 18 or 27 volts for some experimental transistor project? No ned to build a special power supply when a few nine volt transistor radio batteries will do the job.

Simply connect one battery to another as shown in the photograph and take your power from the two exposed terminals.

In this way, voltages in increments of nine volts can be easily obtained. The ampere-hour capacity of this arrangement is not too great so don't use it to power a homebrew five watt transmitter . . . or else you will end up with a pile of dead batteries!



The series arrangement makes it easy to obtain odd voltages in increments of nine volts.

continued from page 4

a great many amateurs feel should be reconsidered, though I'm not sure that the five words per minute requirement for the Novice and Technician licenses is really much of an obstacle.

The extension of the Novice license to five years was proposed on the basis of giving the Novice a longer time to amortize the cost of his equipment. This may indeed be a factor holding Novices back from making a heavy investment in commercial equipment and is worth consideration. I have long felt that the Novice license should be five years and renewable since the restrictions in frequencies are such that they would seem to provide adequate incentive for advancement.

The removal of the two meter phone band from the Novice seemed to me to be unnecessary. The number of Novices using this band has never been more than miniscule and it seems unfair to me to deny those few that are interested in working in the VHF bands the opportunity.

In another move, the EIA has set up an engineering committee to work on developing definitions, performance standards and methods of measurement for amateur radio equipment. They will work on bandwidth, unwanted sideband rejection, carrier suppression, distortion, power output measuring and definition, cross modulation and antenna gain. Stu Meyer of Aerotron is the chairman of the committee. They are biting off a pretty big hunk to chew.

The EIA is launching an industry-supported national advertising campaign to expand the Citizens Band market and will be using television spots, radio, magazines, newspapers and store displays. This is probably a good move to perk up that sagging market. Wouldn't it be wonderful if the EIA worked out a plan to help boost amateur radio in a similar way? Or if the ARRL made such a move?

1968 ARRL Handbook

The 1968 edition of the ARRL Handbook arrived the other day for review. The cover is new, a definite step ahead, I would say. The book has about the same number of pages as last year, about 700, including the advertising section. The price is still $4, reflecting the economies of a non-profit business enterprise and what is, essentially, a relatively unchanging product.

Perhaps it is unfair to review the book in terms of last years edition rather than just on its own merits. I'll try to do both.

In turning the pages of the two editions, side by side, one can see the influence of the new editor, Doug DeMaw, for semiconductors are rearing their heads in greater numbers. All of the new material is, as far as I know, out of the pages of QST. It is difficult to judge, but I would say that perhaps up to 10% of the construction projects are new this year. The influence is particularly in evidence in the VHF sections of the book, which are much more up-to-date than they have been in previous editions. This is logical, since Doug is primarily a VHF-man and By Goodman, the previous editor, was more interested in the lower bands.

The Handbook is offset printed and well done, at that. The photos, for the most part, come out beautifully . . . one of the tests of good offset work.

In all, for the $4 price, you really should get a new edition of the Handbook and keep your library up to date with a new edition each year. $4.50 in Canada, $5.50 elsewhere, $6.50 in hardcover and $7.00 foreign in hardcover.

160 Meter Expansion

Starting July first the 160 Meter boys will have cause for rejoicing. Operators in most of the states will get either more of the band to work with or more power permitted, or both. In some areas there may be as many as eight new 25 kHz segments to use. This is all due to a shifting in the Coast Guard Loran frequencies and locations. If this keeps up we may start looking for 160 Meters on our sideband transceiver bandswitches. Any of the older timers will tell you that, in the olde dayes, 160 was one of the finest ham bands we had.

Caringella Electronics Model ACP-1 Compressor-Preamp

Available either as a kit, or completely wired and tested, the Model ACP-1 Compressor-Preamp is a valuable accessory to amateur radio and CB transmitters for providing added modulation punch and protection against overmodulation.

A low noise, high-impedance FET input stage is utilized in the five transistor, 1 diode circuit. Compression tange is 30 dB. Frequency response extends from 20 to 20,000 Hz. Input and output signal levels are completely adjustable. The unit installs easily in the microphone line. The use of printed circuit layout greatly simplifies the construction of the kit.

Further information may be obtained from Caringella Electronics, Inc., P.O. Box 327, Upland, California 91786. Price: $18.50 in kit form and $26.50 wired and tested.

Catalogs

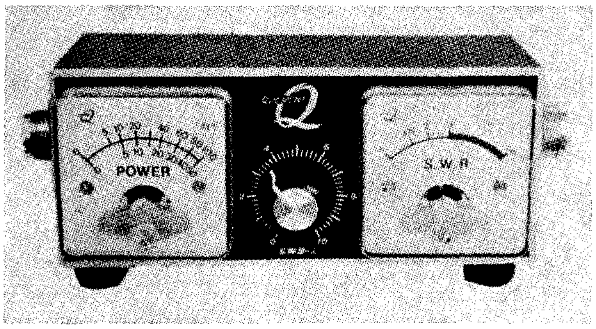
Lafayette Radio's 1968 Spring Catalog is now available free on request. This 132 page catalog contains the latest electronics and stereo hi-fi home entertainment equipment. This catalog may be obtained by writing to: Lafayette Radio Electronics Corporation, P.O. Box 10, Dept. PR, Syosset, L.I., N.Y. 11791.

Amateur Radio Antenna catalog—26 pages, is available free from Mosley Electronics, Inc. Included is a comprehensive discussion of traps, feed systems, unbalanced radiators, SWR, and other pertinent topics. Write Mosley Electronics Inc., 4610 N. Lindberg Blvd., Bridgeton, Missouri 63042.

Quement Model SWB-2 Dual Meter Standing Wave Bridge

The new Model SWB-2 is a convenient, compact, dual indicator device for use in the amateur radio station to check the operation of the antenna load to the transmitter. For VSWR measurements, this unit uses the dual bridge method of comparing simultaneously the power supplied to and reflected from the antenna system. Continuous monitoring of the transmitter output as well as continuous monitoring of the reflected power is possible by having the instrument in the transmission line at all times.

Price is $15.95 from Quement Electronics, 1000 South Bascom Avenue, San Jose, California.

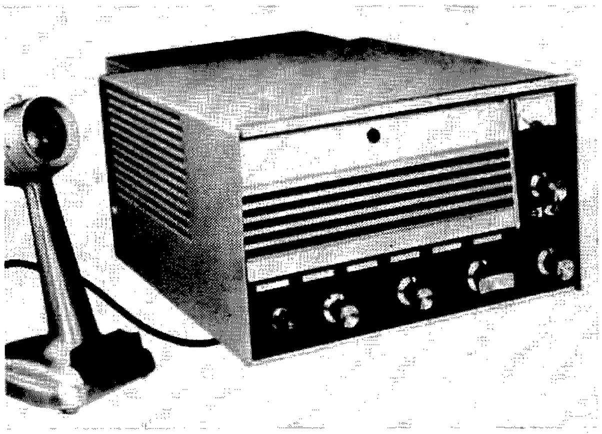


The Transistor Radio Handbook

Editors and Engineers, the publishers of the famous Radio Handbook, have just released a transistor handbook that should be on your shelf. This was written by Don Stoner and Lester Earnshaw, whom you should know by now. The book was obviously written for the average amateur for it will not strain the average intellect. It starts with the usual discussion of holes and the like, and rapidly goes on to the practical applications with the basic circuits and a myriad of construction projects.

The book covers audio amplifiers, compressors, modulators, rf amplifiers, detectors, AGC circuits, oscillators, receivers, from a superregenerative detector right up through a complete superheterodyne. There are simple and complex receiver projects, converters for VHF, product detectors, crystal filters, and transmitting power amplifiers, linear amplifiers, VFO's, etc. Power supplies are covered too, in depth, with do-it-yourself examples of each type.

The book is only $5 and is available at most good parts distributors.



KAAR PH17M Transistorized transmitter for 40/80/160 Meters

This new solid state SSB, compatible AM, and CW transmitter for three band operation on fixed frequencies is now available from Kaar Electronics, Corp. Power output is 90-100 watts PEP depending on frequency and antenna used. Audio frequency response extends from 450 to 2600 Hz, and is down only 2.5 dB at 500 and 2400 Hz with respect to 1000 Hz. The transmitter can be operated on SSB with carrier suppressed 46 dB or more, or in the AM mode with carrier transmitted. Frequency tolerance is plus or minus one part per million per week. At room temperature, frequency stability is better than ±5 Hz when operating at 12.5 MHz.

The Kaar PH17M transmitter employs solid state circuitry throughout, except in the high level stages, and operates from 115 or 230 V, 50-60 Hz ac.

Full details are available from Kaar Electronics Corporation (A member of the Canadian Marconi Company Group), 1203 St. Georges Avenue West, Linden, N.J.

New Books from Sams

Bridges and Other Null Devices, by Rufus P. Turner #20564, $3.25
Understanding bridge type instruments

How to Read Schematic Diagrams, by Donald E. Herrington #20568, $2.95
Shows how easy it is to understand schematics

Test Equipment Cyclopedia, by the *PF Reporter* staff $1.95
Current information on test instruments

Transistorized Amateur Radio Projects, by Charles Caringella W6NJV #20570, $3.25
Selection of transistorized construction projects for the ham

101 *Ways to use Your Ham Test Equipment,* by Robert G. Middleton #20566, $2.95
Explore the total possibilities of your test gear

Audio Amplifier Design, by Earl J. Waters #20560, $4.25
How to design amplifiers either simple or complex

Understanding UHF Equipment, by John D. Lenk #20557, $3.25
Basic background in UHF

So You Want to be a Ham, by Robert Hertzberg W2DJJ #20607, $3.95
Fourth edition of this popular book

Diode Circuits, by Rufus P. Turner #20558, $3.25
150 applications of diodes.

ABC's of Ham Radio, by Howard Pyle #20638, $2.50
3rd edition of this book with impact of incentive licensing

ABC's of Transformers and Coils, by Edward J. Bukstein, #20612, $2.25
2nd edition. Basic principles of inductance, transformer and coil construction.

Tube Substitution Handbook, by the Sams Engineering Staff #20614 $2.25
Over 10,000 direct substitution tubes listed

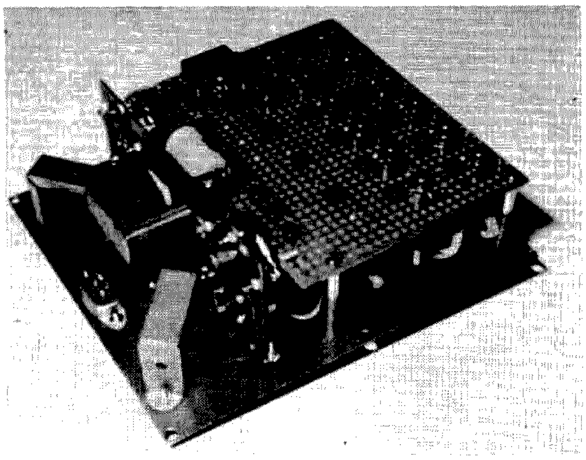
License Plate Holder

One of the nicest little low cost items to turn up recently is a license plate holder which is being marketed by Ken Walkey WB6RSP. Most of the call letter license plates are the standard 6″ x 12″ and they really stand out when mounted in the Walkey holders. Across the bottom in blue letters on white background it tells the world that you are a radio amateur. The holders are triple chromium plated so they will not rust. They are $3.95 a pair from Ken Walkey, Box 3446 Granada Hills, California 91344.

Electronic Circuit Design Handbook

The second edition of this Handbook has been released. The 320 page book will be of value to design engineers and amateurs who spend their days (and nights) at the workbench building. There are over 500 tried and true circuits, along with practical design data. What kind of circuits? Control, regulator, protection, filter, suppression, pulse, comparison, amplifier, oscillator, counting, alarm, timing, converter, inverter, power supply, relay, switching, and plenty of etc. $14.95 hardbound by Tab Books and available in most parts distributors.

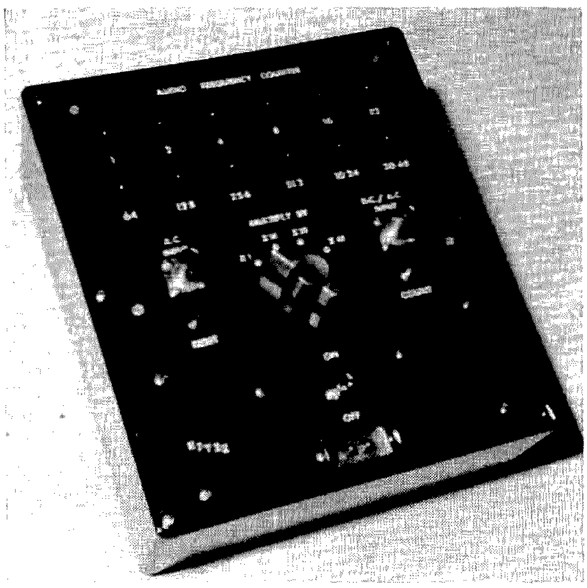
LETTERS



Dear 73,

I imagine from time to time you wonder if any of the articles you publish result in any new equipment being constructed by your readers. Well, I was most interested in the article on the Digital Frequency Meter in the November 1967 issue of 73. The author had constructed the set in three sub-assemblies which I thought was a bit unwieldly to use. So I made a bit of a change in the physical design when I built my unit. The enclosed photographs will give you some idea of how I constructed the counter. I used three low cost 6.3 volt filament transformers in lieu of the transformer called out in the article. The indicator light switches were changed from 2N1302 to 2N1306 which required the 3.9K dropping resistors to be changed to 1K to get proper bulb brilliance. I also used a 2N1304 in lieu of the 2N1605 in the input shaper circuit. No other changes to the circuit were made and the unit works just fine. Keep those fine articles coming.

Louis I. Hutton K7YZZ
Bellevue, WN. 98004



Gentlemen:

It would be helpful, when a circuit is published, to have voltages indicated by the author. This would help us to trouble-shoot if we have problems in getting the circuit to work or if difficulties develop later.

John Kopezynski K7OMS

Dear 73,

In response to the letter in the April issue from K6MVH, no one is more familiar with adjacent channel than I am. After running 750 watts on AM in a fringe area in a town of about 8000 and only one other 6 meter station around, I have had my share of TV set owner education.

I made it a practice to visit, explain, order filters for anyone that was having trouble. While I didn't put the filter on the set, I gave all the help I could so they could put them on themselves.

My article did not state that this cavity would eliminate adjacent channel interference. It did state that it should eliminate harmonics which fall in the TV channels, which is the trouble I had at one time with one particular transmitter.

These harmonics were just strong enough to cause trouble with a few next door neighbors and with the addition of the cavity they were eliminated.

As to reading his article, I read any article I can find on education of either the set owners or the ham when it comes to interference since I feel it is my responsibility to keep informed on any methods used for the prevention of interference.

Keep up the good work. I have every issue of 73 magazine ever printed. I wouldn't miss one for anything.

Don Marqnardt, K9SOA

Dear Kayla & Wayne:

Having never written a "Letter to the Editor" in my life, and after reading the March '68 issue, I felt the necessity! I have taken most articles in my stride since Vol. 1, No. 1, but the one by W7CJB, entitled "Witching for Better Grounds," really threw me for a loop! Being directly, and indirectly, involved in Geology for the past 16 years, I have been periodically plagued by "those witching nuts" with the "Black Boxes," etc. In every instance the method has been kept secret with a "mysterious air" about the whole affair. This article was the first explanation of any kind presented. Not being completely indifferent, and willing to give anything a try—I did just that! Well, count me in—I'm a "nut" too, for the darned thing works!!!

A true skeptic must attempt to test a method, under extreme conditions, in order to discount the entire method. This I tried! On a city lot, and not looking for underground water, I figured that the plastic pipe, leading across the back lawn, to a sprinkler head should be worth a try. (Kept it to the backyard because I didn't want the neighbors to notice that I had finally "slipped a cog!") To shorten the story, IT WORKED!! (Even after I realized that the anti-syphon valve had drained the water from the plastic pipe!!!) Ultimately, I wound up in the front yard working on locating the ¾-inch galvanized waterpipe from the city water main! And again it worked, not only for me but for the XYL and YL harmonic! Then it happened! The next door neighbor shouts over—"HEY! You looking for gold??" It was earth-shattering enough to find out that the "witching" works but now the whole neighborhood was in on it—and on the first day of trials, too!

Within hours, as a result of the curiosity and tests, I became a "believer" and the neighborhood "nut!" But so long as the damage has already been inflicted, I intend to continue with the tests to determine more of the "Why," now that I know that it works!

As a result of many of the 73 articles, since 1960, I have benefitted considerably; but I don't believe that I have been more surprised than the results derived from that article. I don't have a counter-poise nor ground system to put in but the "witching" sure modified my thinking as to the possibility of it being done! (And it's no "April fool" either!!)

George Wilson WA6LNA

Dear Wayne,

Re the article in March 73 entitled Transmitter Keying with Transistors, the RCA 40264 appears to have been withdrawn. A better and cheaper substitute is the RCA 40424 or the 40425. Both have a B Vcbo = 300v, Ic max = 150 ma. The 40424 (98c) will dissipate 8 watts/250°C and the 40425 ($1.06) with attached heatsink will dissipate 3.8 watts. This transistor is also ideal for screen grid keying (differential type keying) and RTTY operation. In either case it is a good idea to connect a voltage suppressor from collector to emitter. A Sarkes Tarzian S-255 or C-871, about 65¢, should do the trick.

Ross Lunan VE2APN

Dear Wayne:

I miss your "controversial" editorials in 73, even though I didn't always agree with you. I think that the new licensing setup will work out fine, but I realize that I may be all wet.

What I really wanted to talk about was your EI column on the current DX situation. On this, I couldn't agree with you more. It would be hard to imagine anything more asinine that setting up an elaborate radio communication station, only to be prohibited from communicating, and only be allowed to swap inflated signal reports, and finally to receive a QSL made out by the local QSL manager. I like to work the G stations, because I can at least have a QSO with them, without making anybody mad at me. It sure would be nice if I could do the same with stations in other countries.

Whatever happened to the idea of having a friendly rag chew with the guy at the other end? That's what ham radio is all about, after all. It seems like a poor exchange to give up all real communication and substitute a fine print listing in magazine "honor roll."

How about starting a "DX Rag Chewer's Club" or something to give a little competition to DXCC, etc.?

Bob McGraw W2LYH

Editor 73:

Thank you so much for the first of a new series of articles starting on page 92 of the March issue of 73.

The style and manner of presentation of this material is something I have been longing to see for a long, long time. The author, or authors, of this material have struck upon a manner of presentation that has my complete endorsement. The material is presented in such a way that I get the impression the author wishes to communicate with me and pass on for my understanding the material he has to present.

Regardless of whether I happened to be interested in getting a higher grade of license or not, I would pick up and follow this material because it is presented in the manner in which I like to approach things. It makes the acquisition of this knowledge fun. The author does not seem to be afraid to attempt to use words and word pictures that take on a concrete image in the mind of the reader.

I would like to see your magazine content expand along these lines with more and varied educational articles, above and beyond what you contemplate to tie into the incentive license program.

Clayton Gordon W1HRC
P.O. Box 85
West Main St.
West Millbury, Mass.

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

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★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

TRADE, NEW KW Matchbox, 250-30-3 Johnson for 2 meter gear or? Bud WAØIQA, 2045 Oswego, Aurora, Colo. 80010.

FOR SALE: Swan-400 SSB transceiver; Swan 420 VFO, complete with VOX and Mike. New units, never used. Also Eico 753 factory wired SSB transceiver with Eico 752 wired power supply, also new. Private party. Ernest E. Dutcher, Bx. 1393, Studio City, Calif. 91604.

FOR SALE: 120' Rohn Galvanized 18" tower, $2/foot. 160' non-galvanized 18" tower, $1/foot. Will sell any amount. Want mobil rig. Floyd J. Phillips, WAØJTM, 458 E. 2nd, Russell, Kans.

THE SUBURBAN RADIO CLUB of St. Louis County, Mo. will hold its 3rd Annual Hamfest on Sunday, June 30, 1968 at the Creve Coeur Memorial Park in St. Louis County. All Hams, CB'ers and their families are invited. Food available on the grounds. Advance registration $1 from KØAHD, WØMUX or WØJUY.

DISCOUNT PRICES—TIME PAYMENTS. All new equipment, factory sealed cartons, full warranty. Drake T-4XB $375, R-4B $375, L-4B $595, TR-4 $510, Galaxy V Mk. 2 $365, National NCX-200 with AC-200 power supply (Reg. $434) $369, NCL-2000 $595, SBE SB-34 $380, SB2-LA $219. New Ham-M Rotator & Indicator $99.95, TR-44 $59.95. All new equipment described above in factory sealed cartons, full warranty, immediate delivery. Time payments on any purchase. New Hy-Gain, Mosley antennas at discount prices. Write for quote on any type equipment. Reconditioned specials—Swan SW-500C $395, SW-250 $240. Time payments. Send for discount price sheet. Edwards Electronics, 1314—19th, Lubbock, Texas. 806-762-8759.

WELLS GARDNER RBL-3 VLF recvr. with 8 ft. electrostatically shielded loop antenna for 20KC. $45. K6PAK, Monrovia, Cal. 359-7255. Cannot ship.

KNOB, for Collins 75A-receiver, 6 to 1 reduction. $7 postpaid. Jules Wenglare, W6YO, 1416 7th Ave., Delano, Cal. 93215.

FOR SALE. 75A4, Serial 4190, .5, 2.1, 3.1 filters with SB610—$475; HT-37, 3 xtals full 10 mtr coverage—$250. B&W L1000A linear with input tuned ckts—$175. HX20, HR20, HP20, HP10 plus mobile mike—$250. Joseph Soroka, Jr., W3LGD. P.O. Box 8, Irwin, Pa., 15642.

CLEANING OUT! VTVM $18, Sine Wave Gen. $14, Precision E-200C $35, Capacitive discharge ignition $25, Resistance decade $10; also have magazines, books, parts, cabinets and much more. You pay shipping, postcard for list. K2EMF, John R. Yurcik, 510 Conklin Pl., Linden, N.J. 07036.

MOTOROLA 80-D 12 VDC. Very clean, no cables or head $65. DX-100 $50. Model 15 Teletype printer only $60. W. M. Richarz, 519 Davie St., Fayetteville, N.C. 28301.

WRL'S USED GEAR has trial—terms—guarantee! SR46—$99.95; Utica 650A & VFO—$99.95; TX1—$99.95; Valiant—$149.95; HA10—$189.95; SX99—$79.95; HQ100C—$109.95; 75A1—$169.95; SX140—$69.95; HR20—$79.95; NC300—$149.95; RME4300—$79.95. Low prices—hundreds more. Free "blue book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

HQ-145C, EICO 720 FOR SALE. Also VFO and accessories. Used, but clean. A complete operating station. David Bantz, NYC (212) 222-2116.

THE WOOD COUNTY AMATEUR RADIO CLUB announces its 4th Annual Ham-A-Rama Sunday, July 7 at the fairgrounds, Bowling Green, Ohio. Write W8PSK, 324 South Grove St., Bowling Green, Ohio 43402 for details.

COMPLETE FIXED AND MOBILE: SBE-34 with microphone and built-in calibrator, modified for CW, with key. Deal includes Webster band spanner and mount. Less than 18 months old and not used for last 6. With all cables and instructions. $300 takes all. R. V. Palmer, 2642 Maplewood Dr., Longview, Washington 98632.

COLLINS 62S-1, serial 11744 for sale, $525; and (2) 4CX1000A's, perfect condition, $40 each. Vince Varnas, K8REG, 4329 Renwood Dr., Dayton, Ohio 45429.

TORIODS, uncased 44 of 88mH, also individually epoxy encased 8mH for standards, any 5 $1.50, 255A relay $2.10, 18B socket 70¢ all PP USA. E. W. Evans, K4OEN, 220 Mimosa Ln., Paducah, Ky. 42001.

SELL/TRADE: HB 432 KW Linear Amp/PR 4CX250M's, 432 PRK Amp/(2) 2N3478's, 144 To 432 Tripler/4CX250B, Modulator PR813's with EICO720 Driver. Desire a Comm or good HBKWLinear for 2 MTR's. Write: W9FZD, P.O. Box 13, Oakcreek, Wisc.

FOR SALE: NC-300 with speaker & converter cabinet 6M Parks conv. $150, G-76 with 12VDC supply $120, Globe 300-A $120, SCR522 with supply $30. K7UNA, Rt. 1, Box 200-B, Quincy, Washington 98848.

TEST EQUIPMENT, ETC. Large variety, including H.P. 400B $45; Simpson 260 $30; 269 $45; 388 $30, Beckman counter #7370 10cps-10mc $650; Tetronix scope plug-ins $30 to $125; BC 659 Transc. $10. Send 25¢ for large list. Palen Electronics, P.O. Box 1536, San Mateo, Calif. 94401. Phone 341-9747.

COLLINS 7SS1, 32S1, speaker and AC supply. Lot $575. Also 4-400's G.C. amp, all in good working condition. K2HDU, 7 Johnson Ave., Plattsburgh, N.Y.

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NCL2000 new $495.00—Banger 11 f/w, new, $250.00

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ARC-1 Transceiver 100-156 Mc. 28 tubes. $20.00
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Loading Capacitor, 5-sections, 400pf. per sections, with 1/4" saft adapter. $2.30
APT-5, $45.00 APT-9, $45.00
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CONVERTER SALE: three transistor, 50-54 Mhz input, 14-18 Mhz output, wired, tested printed circuit. Crystal controlled, $6 ppd. Adjustable, $5 ppd. Syntelex, 39 Lucille, Dumont, N.J. 07628.

ON AIR NOW: Apache-TX-1: SB-10: Heath SWR Bridge: Xtal Mike: All new tubes. First $159.95 cash or check takes it prepaid. J. F. Weatherly, 473 Auburn, Newton, Mass. 02166.

RCA CMV-3 52.525 f. m. on a. c. 2nd limiter metered guaranteed $75. 140-D high band on a.c. no case $45. Larry Davis, Amboy, Minn. 56010.

WANTED: Johnson 6N2 Thunderbolt. SALE: Heath HO-10 Monitor Scope Kit $50. Rich Flaskerud KØGEY, RFD #1, Calmar, Iowa, 52132 (319-562-3803).

THE SIX METER CLUB OF CHICAGO is having its 11th Annual Picnic and Hamfest. It will be held August 4, 1968 at the Frankfort Picnic Grove, 1 mile north of Rt. 30 on U.S. 45, Frankfort, Illinois. For further information contact Michael Corbett K9ENZ, 5215 73 Ct., Summit, Ill.

THE ASSOCIATION OF RADIO AMATEURS OF THE REPUBLIC OF MEXICO will hold it's VIII Great National Convention in the city of Laredo (across the border from Laredo, Texas) July 12, 13, and 14th. Headquarters will be at the Hotel Monte-Gar with three banquets offered by the Chamber of Commerce of Laredo, Texas, the Governor of Tamps, Mexico, and the Mayor of the city of Nuevo Laredo, Mex. Technical talks and displays, along with the usual goodies.

FOR SALE—SX-111, Eldico SSB-100 Transmitter, Heath HO-10 Monitorscope, HG-10 VFO, AM-2 SWR Bridge, NCL-2000 Linear and all sorts of homebrew equipment including 6M Exciter, 500w Amplifier, converter, etc. Send for list or call 617 453-7515. Steve Stark, WA2ENM, 77 Livingston Ave., Lowell, Mass. 01852.

THE KNIGHT RAIDERS VHF Club will hold its Second Annual Hamfest on Saturday, July 20, 1968 at Weasel Drift Picnic Grove, Garret Mt. Reservation, West Patterson, N.J. from 10 am until dark. The location is the same as last year. Manufacturers displays, swap shop, junque tables, contests, door prizes, and a good time for all will be the order of the day. Picnic tables and barbeque pits available. No tickets, no fee, it's free. Refreshments will be available. Talk in station K2DEL/2 will operate on 50.4 MC and 146.898 MC. Special certificate for contacting the talk in station available. For more details write K2DEL.

WANTED: Military, commercial, surplus, Airborne, ground, transmitters, receivers, testsets, accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

DUMMY LOAD 50 ohms, flat 80 through 2 meters, coax connector, power to 1 kw. Kit, $7.95, wired $11.95. pp Ham KITS, Box 175, Cranford, N.J.

LOUISVILLE HAM KENVENTION, Saturday, August 31 at the Executive Inn, featuring Dealers and Manufacturers; Technical Forums; Prizes; Contests; Fashions for the Ladies. 648 South Fourth Street 40202.

RTTY MODEL 15 and 14 TRFX with TD and power supply mounted on portable stand beautiful mint condition. Cash and carry $150.00. W3VYY, 133 Morlyn Ave., Bryn Mawr, Pa., 19010, Ph. LA 5-8849.

MECHANICAL ELECTRONIC DEVICES CATALOG 10¢ . . . Teletype Model 14 reperforator with automatic tape take up rewinder 115VAC60cy. Both units new, unused $69.95 . . . ARR27 Receiver 29 tubes 465-518 MHz w/60 MHz if new, unused $35 . . . 1/16 laminated copper clad 2 oz. 2 sides, for printed circuits 9½ x 4½ $1 . . . 3/$2. Transistor boards bananza $5.95 . . . Wide band balanced modulator $4.95 . . . 30 MHz IF Assembly $5.95 . . . Transmitter TDG w/Modulator easily converted to 2 meters $49.95 . . . Low pass filter 0-32 MHz 52 ohm $9.95 . . . 5KV/2KV/1KV at 750 ma/200ma/250ma Power supply. Write for details. Fertik's, 5249 "D", Phila., Pa. 19120.

HTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

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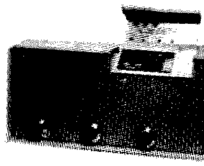

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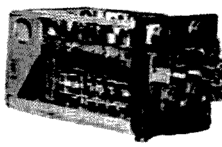

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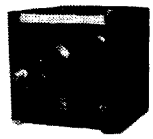

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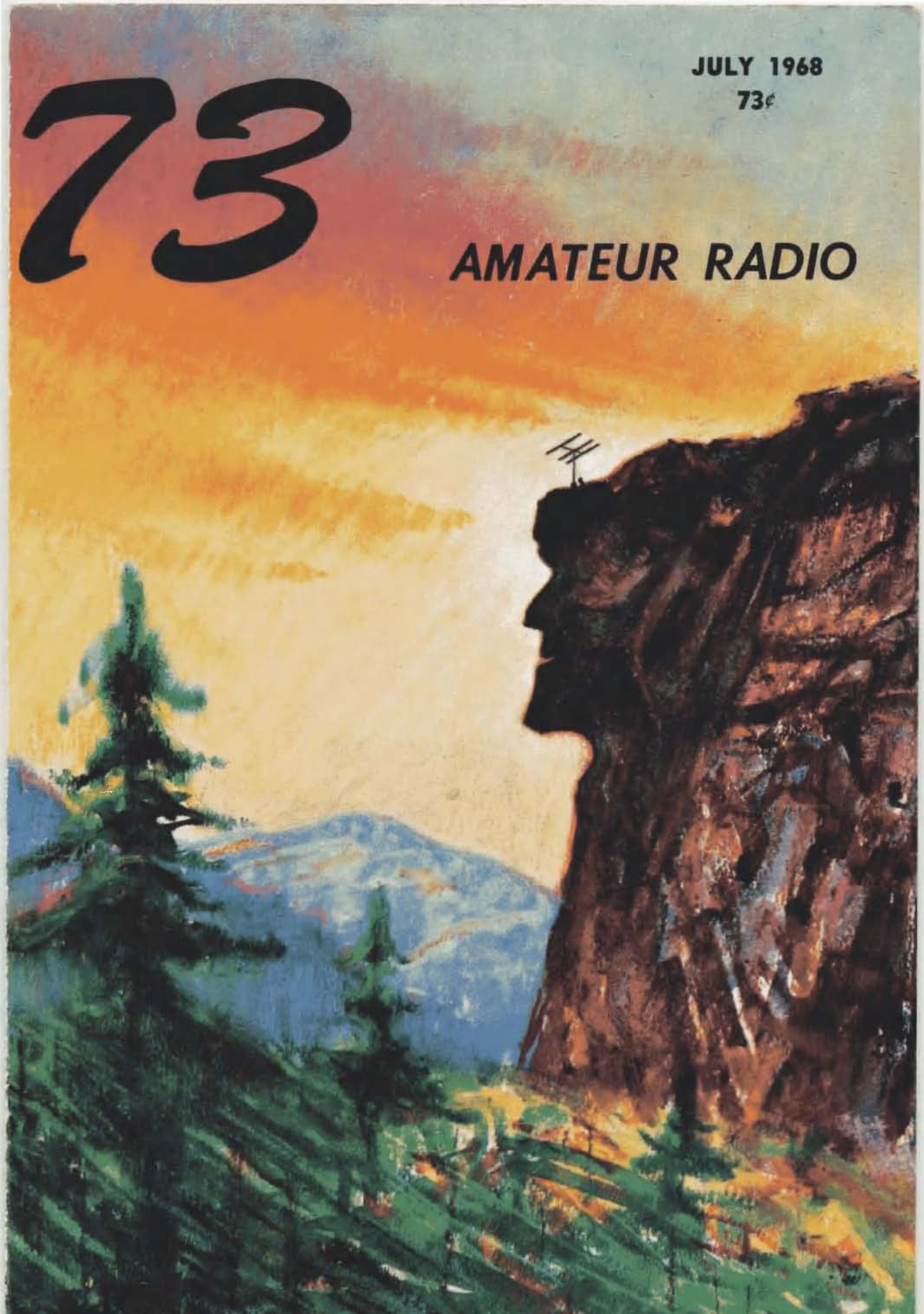
73
JULY 1968
73¢
AMATEUR RADIO

73 MAGAZINE

July 1968
Vol. XLVII No. 7

Effective August 1, 1968 Subscription rates will be as follows: 1 year $6.00, 2 year $11.00, 3 year $16.00. Renew now to save expenses.

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Wayne Green W2NSD/1
Publisher

Kayla Bloom W1EMV
Editor

Cover: Original painting of New Hampshire's "Old Man of the Mountain" by Sydney Willis.

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. The phone is 603-924-3873. Subscription rate: $5.00 per year, $9.00 for two years, $13.00 for three years. Second class postage is paid at Peterborough, New Hampshire, and at additional mailing offices. Printed in Pontiac, Illinois, U.S.A.

Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458. Engage brain before turning on transmitter.

Editorial Liberties

. . . Kayla WlEMV

Last month we had so many articles in the magazine that I found it necessary to bump my own editorial in order to make room for a second page of "table of contents". This caused me deep regret because I wanted very much to press for all hams to write their congressmen to support H.R. 16764 introduced April 24, 1968 by Congressman Theodore R. Kupferman of N.Y. The bill was referred to the Committee on Interstate and Foreign Commerce and there is a possibility that it may not have seen action so far. I urge you to phone or wire your congressman immediately to support this measure which provides for licensing of foreign amateurs who have taken up permanent residence in the U.S. and intend to become citizens. We allow (through the reciprocal agreements) visitors and those foreign hams who are here working or as students to use their licenses, but the tremendous number of aliens who have filed their intent to remain have no such opportunity.

The overwhelming enthusiasm which greeted my May editorial on the 40 meter foreign broadcast intruders has caused me to ride that horse again this month. If the actions will speak as loud as the words, we should have quite a gang riding the 40 meter broadcast stations and trying to force them to move. All kinds of suggestions have been made for how to take action against the intruders ranging from "Give amateurs unlimited power on those frequencies from 6PM to 6AM local time" to "use those frequencies for a dummy load."

How about this approach? Give them QRM in any way you can, but be legal about it. We don't want any charges of malicious interference. Carry on QSOs as close to their frequency as you can manage. Then, start a campaign getting everyone you know to write to Radio Moscow and BBC, and any others you can identify saying, "I would like to listen to your broadcasts, but there is so much interference from the amateurs in the 7 Mc band that I find it hard to hear you. I wonder if you could move to a frequency above 7.3." or words to that effect. An other idea is for us to write to the Minister of Commerce in those countries telling them that We are planning a vacation and would like to visit their country but since we are amateurs, we feel they are depriving us of our rights to use our legally authorized ham bands and therefore will *not* visit their country and will urge all our friends to remain away. As you know, tourism is a big business in most countries and a pile of letters from would-be tourists who will *not* spend money in that country is an influential factor. We could probably cause a grand fight between the Minister of Commerce and the Communications department if enough letters were sent. Any other ideas? Talk is cheap, action is what is needed. Multiply your Q, sharpen up your receiver's selectivity, and get on 50-100 cycles off zero-beat from your most obnoxious foreign broadcast intruder and give it all you've got. There is nothing illegal about calling CQ even if you can't hear the station who might answer you. Soon as some manpower comes along to assist, I'm going to put up a rhombic aimed for Europe and call CQ with the full legal power. Anyone going to join me?

With this issue we are starting with full color covers for 73. Cover material has always been a problem and it is a monthly hassle to figure out what to use. We have used photos, cartoons, artwork of all kinds in the past. We now put out a call for ideas backed up with material. For this July issue we have a painting of a view of New Hampshire's "Old Man of the Mountain" with the embellishment of a beam. This was specially done to attract you to our hamfest July 6th. Full color photographs of any ham topic would be acceptable. However, since most ham shacks look pretty much the same the world over, we will eliminate them from competition. An interesting new antenna would be good, but they are hard to photograph. Naturally, you will be handsomely paid if we use your cover idea, and you will have your photo or painting returned politely if we don't.

Apparently there is some misconception that your editor is also Mr. Green's wife. I would like to clarify this. Wayne and I are good (but not close) friends. I have enough troubles without having to live with him. Furthermore, he is married to a lovely girl named Lin, while I am unattached.

de W2NSD/1

Now that Don Miller and CQ magazine have joined forces, with CQ putting their reputation on the line backing Don and the validity of his expeditions, Don's reported suit against the ARRL for $550,000 takes on an added dimension, unfortunately, a court case like this can drag on for years and, win or lose, will cost the ARRL members dearly.

In addition to the suit against the ARRL, Don has also instituted a suit against 73 for $655,000. One can only guess at the reasons for such a move on his part. It is unfortunate that this whole matter has come to the courts for this will undoubtedly stifle reporting on Miller and his expeditions and will make it even more difficult if not impossible for us to get him to come up with explanations backing up his past trips.

How simple it would have been for him to just tell us that he went on such and such a ship from such and such a port on his trip to, say, Heard Island. He could tell us who was with him on the trip to back up the story and when he left, arrived, and returned and to where. He could show us a photocopy of the permission to operate from the Australian government for Heard, etc. All of this seems so simple, yet, despite my many questions, all we have is a libel suit and the prospect of having to wait years for any answers to all of our questions.

When Don visited the 73 offices about a year ago, we discussed his doing a DX column for 73 and a DX handbook. I had been looking for an author for my DX Handbook for some time and had discussed it with several well known DX'ers such as W1FH and W9IOP. I made it most clear to Don that the column and the book were possible only if all questions about the validity of his operations were cleared up to the satisfaction of the ARRL. Despite his assurances, the questions did not clear up at all . . . they continued to grow. Don was most perturbed with me when I refused to budge on this condition to his writing for 73. He is still perturbed . . . and the questions remain unanswered.

Rather than go into a long detailed discussion of the attack that Don Miller has made on me in his "article" in *CQ*, I would like those readers who think he may be right to consider his basic premise . . . that 73 is built on controversy and that I create controversy because it is profitable.

In fact, controversy has been one of the major factors holding back the growth of 73. My outspokenness has discouraged many advertisers from appearing in our pages. It has brought in ten letters of complaint for every letter on encouragement. Renewal after renewal form comes back to us saying that the reader is fed up with 73 because of the controversial editorials. And every editor who has worked for 73 has tried to get me to soft-pedal my columns.

From time to time I have been quiet and, just as everyone promised, the magazine has grown at a much faster pace. Then, when I felt that something had happened that everyone should know about, things would slow down again.

Neither money nor fame have been driving forces in my life. I want, more than anything else, to leave the world a little bit better than I found it. This is why the focal point of 73 has been technical and construction articles. That is why I try to report on the things that are going on in amateur radio to the best of my ability and in spite of enormous pressures to shut up.

Like most other people, I am my own worst enemy. It is all the more frustrating when you realize this, but still can't do anything about it: If I were smarter . . . if I were a better writer, just think what I might be able to do! But I'm not and I try to make up for it by working harder than other people and by being honest about what I am doing and why I am doing it.

Don was apparently quite intrigued by a little booklet I have written on "How To Make $1,000,000." Oh, I haven't done it . . . I haven't even come close . . . and I don't expect to. But that hasn't stopped me from doing a lot of thinking about the subject and figuring out some answers for those who are so inclined. If a fellow has as his goal retirement with enough income to keep him going the rest of his life, I believe I have worked out an almost foolproof system that will make this possible for him before the age of 25. My system does not include college, working for large corporations or the government. It is, in all, a rather unusual approach. The booklet is available from 73 for $1. *Turn to pg. 65*

G. Cousins VE1TG,
Lower Sackville
Nova Scotia, Canada

Let's Build a Tower

A few years ago the urge hit me to quit messing around with the assortment of wire creations that I'd always used for radiators, and start in on rotary beam construction. Undoubtedly a lot of other hams have come to the same decision and, like me, soon realized that buying or building a beam is just part of the bargain. It has to be rotated, and it has to be mounted up in the air. The cost of a good beam can be fairly reasonable, but by the time the tower and rotator are added the whole thing begins to look like a payment on the national debt. However, all is not lost if you can convince yourself that you can take a few simple tools and build the whole affair right in your own backyard. It takes a little time and patience but the savings are well worthwhile.

I won't go into the construction of beams or quads at this time, but it seems logical to first decide what kind of antenna you're going to build and then tailor the tower to that particular design. There is also the human angle to consider. I for one like to be both safe and comfortable while I'm on top. And there is the problem of real estate; which simply means you must keep your tower and its accessories within the confines of your own property. Keeping the cost factor in mind, the tower described here was built according to these requirements:

1. Wooden construction, using only simple hand tools and a hand drill. Metal construction would be fine, but would necessitate much more in both cost of materials and more elaborate tool requirements.

2. Completely self-supporting and capable of handling the load of three stacked full size beams in winds of 100 m.p.h.

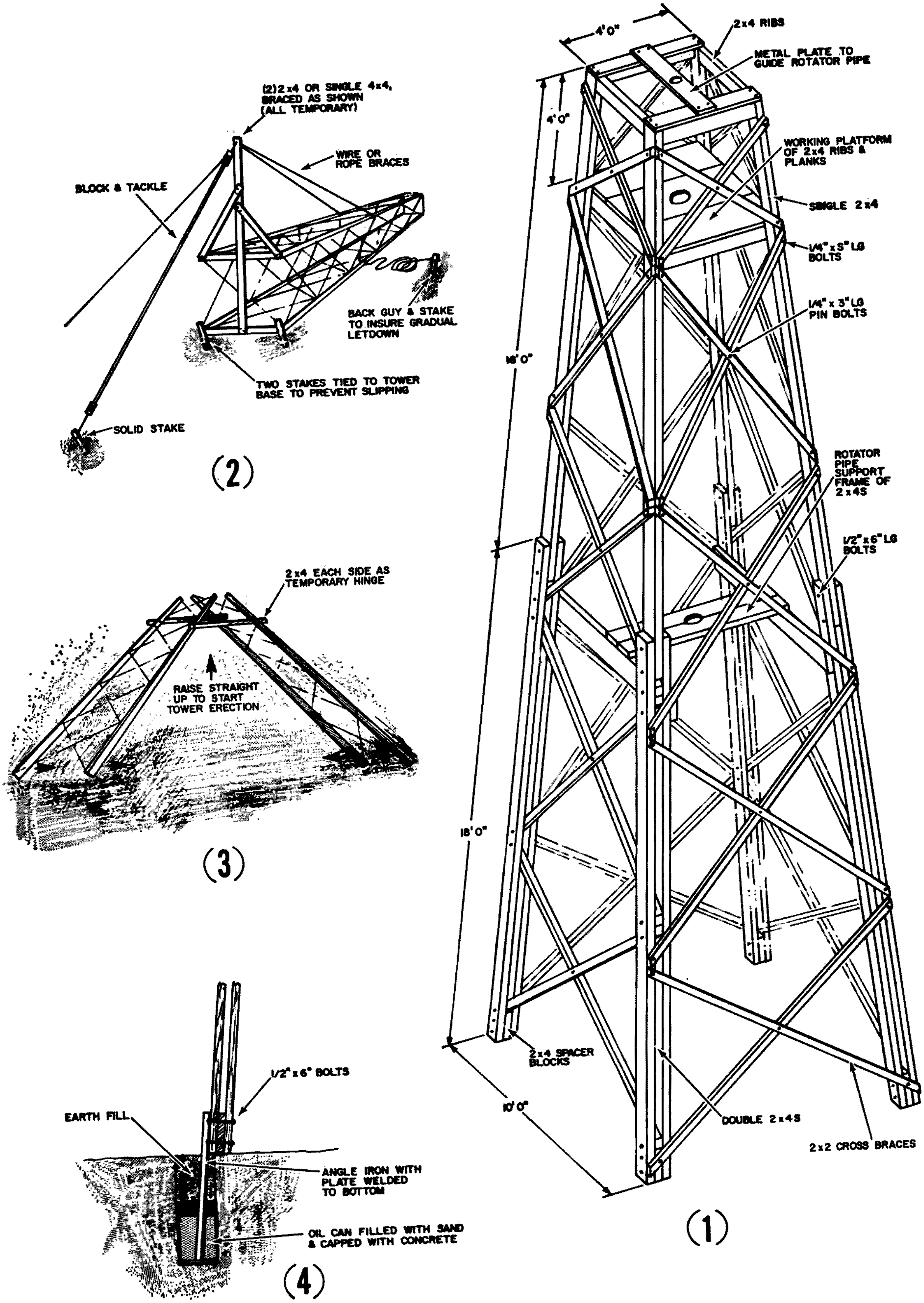
3. A wide working platform at the top, enclosed inside the tower, and with enough room for two or three men to maneuver comfortably and safely.

4. Easily built by one man and raised by four.

Before rushing off to buy materials, one should consider the type of lumber needed and this is pretty well dependent upon height and weight considerations. It's all very well to place a 20 meter beam at 70 feet in the air, but this is not practical unless you are going to get involved with much higher costs than are necessary. This tower of mine stood 33 feet from the ground to the top of the actual wooden frame. The rotator pipe extended two feet higher to the boom of the 20 meter beam. Therefore this beam was an approximate half-wave above ground, and its operation was perfectly satisfactory in both DX chasing and contests. Three feet over the 20 I mounted the 3-element 15, and four feet over that was the 4-element 10, making a total of 42 feet to the top of the mast. If your antenna is going to be a quad, this height will be quite satisfactory, even more so because of the quad's well known ability to perform beautifully at the lower elevations.

With due consideration for safety, the legs of the tower should be at least 2 x 4, and by referring to the overall diagram of the tower, you'll see that the lower part of each leg is actually made of two 2 x 4's with spacer blocks spiked between them. The upper leg is a single 2 x 4 which is inserted about 4 feet between the bottom two. This joint is rigidly fastened together with husky bolts. This is a good time to point out one construction feature of this tower; that is the use of bolts instead of nails. The cost is higher, and probably nails would be satisfactory if you use the newer spiral type, but I personally prefer bolts so the choice is yours. The wood sections should also be given a good coat of exterior primer and one or two coats of exterior house paint before they are assembled. Aluminum paint is also very good, and I would suggest buying it in the gallon size. It's much cheaper this way, and you'll certainly use it all!

In selecting the wood, the only proper way is to go to the lumber yard and keep



Composite details of VE1TG Tower. See Text

digging until you find just what you want. Have a chat with the yard boss and he'll certainly assist you to find the proper materials. Buy a good grade and make sure each piece is as knot-free as possible. If you don't know much about comparative strengths, ask for advice, and then buy the strongest type available. However, if you're in a real small yard and there's not much choice, don't give up. My tower was built from plain ordinary spruce and it's been standing for six years in some of the wildest gales you'll ever see, and it hasn't shown any signs of stress up to now. However, I did take care to give it lots of paint and I also made sure I had very few knots in any of the legs and braces.

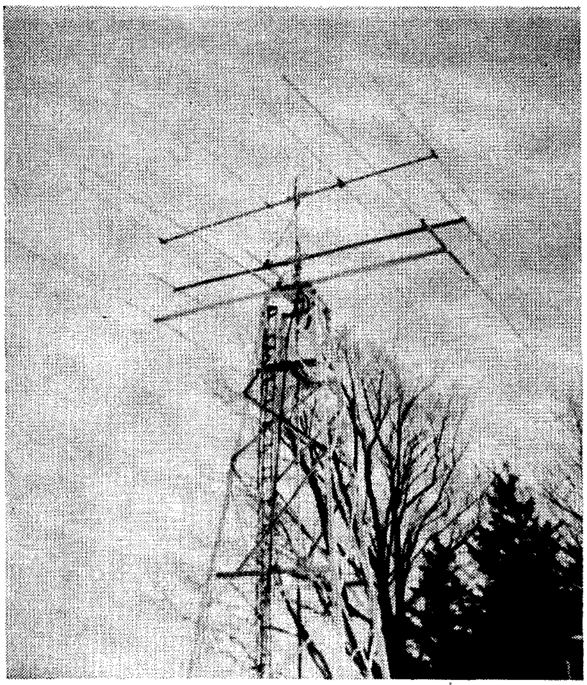
Everyone has ideas about constructing a thing like a tower, but I found it easiest to build two complete sides, each lying flat on the ground. For one thing, this makes it much easier to get the dimensions right and to end up with both sides being the same. The actual construction will be pretty clear from **Fig. 1**, with the cross braces all being made from 2 x 2 stock. You will find that this 2 x 2 will give an extremely rigid frame, but it is almost mandatory that bolts be used rather than nails. When the braces are crossed over themselves in the center, there is considerable strain placed upon the ends of each brace, and nails will almost certainly pull out of the legs. This is especially true of the shorter braces at the top of the tower.

I made the tower with a top width of 4 feet, and a base width of 10 feet, giving an approximate 3-to-1 ratio between height and base; or in other words, 16 square feet on top and 100 square feet on the bottom. This caused some of my friends to feel it would be rather "spraddle-legged" but the final appearance is very pleasing. The most important thing to remember is that this ratio makes the tower extremely stable and eliminates the need for guy wires. This one has taken hurricane winds of more than 100 m.p.h. on quite a number of occasions without any sign of damage, and without the slightest indication of becoming unsteady.

After the first two sides are finished, some thought should be given to erection before proceeding further. If yard space is very limited, it may be necessary to carry on and build the whole tower in one piece. If so, the same general methods can be used for the other sides, since all that will be required is to fit in the cross-braces. You must be careful that the dimensions are correct or the end result could be lop-sided, but by taking a little time and measuring carefully you should have no problem. The platform can be built into the tower, about 4 or 5 feet down from the top. This allows you to eventually stand safely *inside* the tower with a good solid frame all around you—quite an important feature if you're nervous about height or want to persuade some friend to come "topside" with you.

If you have built the whole tower in one piece, erection can be done quite easily. The only equipment needed is a block and tackle, a couple of pieces of 2 x 4 and a friend or two to give a helping hand. If you can get a car into position to pull straight on the tower, even the tackle can be eliminated. See **Fig. 2** for a suggested method of carrying this out. As the tower passes the "point of no return" there should be a man at the rear letting out the back rope carefully so the tower will not come down with a real bang. Probably no harm would be done, but why take chances?

The second method of completing the tower is shown in **Fig. 3.** The two completed sides are laid out end to end, and side braces of scrap wood are added to the top ends in such a way as to form a crude hinge. The braces must be fastened to the legs by means of bolts, and the bolt holes must be large enough for them to act as swivel pins. Now the center of the whole affair is raised by means of a step ladder or even just spare pieces of lumber acting as props. Now four men can grasp the legs and "walk" them inward—with the result that the tower rises smoothly until it is at the desired elevation. By marking the proper position for the four legs ahead of time, the legs can be walked in and set down in just the right place. This is the method we used for this tower and it is quite easy to do. Total erection time was about fifteen minutes. Of course when the tower is up it must be temporarily guyed as it has only two legs and is a little shaky. This condition is only of short duration if you make sure to have several pieces of the 2 x 2 cross brace material all ready at hand. As soon as the tower is vertical, go to work and install the cross braces, working from the ground up, and in the space of a few hours you can easily have at least half of the


The completed tower with antennas installed.

remaining braces securely in place. In fact if you can persuade the friends to stick around after the raising procedure you can probably get the whole thing finished by sundown. This is what I did, with the aid of four pals and supplemented by the XYL's sandwiches and a few gallons of good old Nova Scotia cider!

With all the bracing completed, all that remains is to build the working platform into the top. In the main diagram **Fig. 1**, you'll notice a hole is cut in this platform for the rotator pipe to pass through. About 16 feet up from the ground is another frame made from a couple of pieces of 2 x 4, also with a hole cut in it. This was necessary because I started out using a very large rotator made from a surplus D. F. antenna mount, and the thing was so big and heavy I had to leave it on the ground and run the pipe all the way up. Since the usual ham rotator won't be this big, it will normally be best to mount it up near the top and the platform can become an excellent mounting base for rotator and any extra control box which may be necessary. There is enough room to pull up a folding chair and work away in real comfort!

The metal plate shown at the very top is best made from a heavy piece of aluminum but iron will do if you give it a couple of good heavy coats of rust-proofing and paint. There should be either a sleeve or thrust bearing installed at this point but the exact type will depend upon your own rotator-pipe combination.

With your tower now completed, the footings should be considered. In my own case I found the thing so stable I used only old pieces of angle iron driven into the ground and bolted to the legs, but a better anchor can be easily made by digging the four holes and using old oil cans (from the local garage) filled with sand and capped with cement. Before filling them, make up a "T" from a couple of pieces of angle iron, bolt this to the mast leg, and let the angle iron act as a foot at the bottom of the can. Using sand is cheap and the top few inches of the can is easily capped with a bag of ready-mix concrete. Then tamp down the earth firmly over the whole affair. If this sounds pretty confusing, refer to **Fig. 4.**

One thing is still missing—an easy way to climb the thing. Well of course the easiest way is to construct a ladder and mount it on one side of the tower. Four lengths of 2 x 4 will be required and the rungs can be made from the left-over scraps of 2 x 2, or you can use short lengths of scrap pipe. My own method was to use two fifteen foot lengths of TV tower of the type that has horizontal cross braces on one side. This was mounted inside the tower and proved to be ideal for the purpose. Of course this is really a waste of money unless you happen to have the stuff already laying around so in the interests of economy I'd suggest the wooden ladder.

As a last "selling point" on the strength of this tower, after it was in use for about two years, it was taken down in one piece, loaded onto a trailer, pulled down the highway to a new QTH and put back up where it is still standing as solidly as ever. Total cost of the tower was approximately $55.00 including the paint and considering all its features of convenience, safety and load-bearing ability I think you'll find it hard to beat. . . . VE1TG

Why Not a Tilting Tower?

Norm Watson W6DL
5501 Via del Valle
Torrance, California 90505

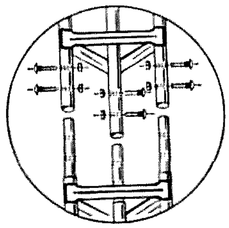


FIGURE 1

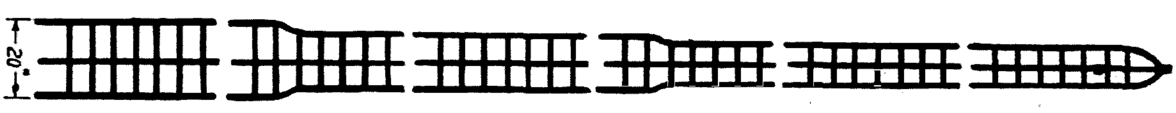
Fig. 1. Method of joining sections together.

This article describes a sixty-five foot tilting tower made up of commercial TV tower sections and two home brew tilting sections which are hinged together. Tilting of the upper portion of the tower is accomplished by means of a twenty foot cantilever boom which is attached to the upper tilting section and controlled by means of a boat winch attached to the tower at ground working level, with the winch cable secured to the lower end of the boom. The tower can be tilted down or raised in a few minutes and provides safe access to the rotor or beam working at ground level or from a moderate height step ladder. The idea for this type of tower is not new; however, the particular tower described here is not commercially available. It was built by the author for $260.00, included all costs for galvanizing, winch, shipment of purchased tower sections, etc.

The tower sections used are manufactured by Reference 1 and are the model 500 Super Kwick-Climb, hot dip galvanized units. These triangular sections are ten feet long and when two sections are bolted together, 5½ inches of tower height is lost due to overlap. Construction is of 1¼ O.D. x 16 ga. wall high strength tubing with cross braces spaced on 13" centers. Method of joining sections is shown in Fig. 1. Sections available are shown in Fig. 2. The tower pictured utilizes two F sections and one each of sections A, C, D, and E for the tower proper and one each of sections A and B for the boom. Two tilting sections must be fabricated and interposed between sections E and F at 20 feet above ground.

As shown by the close-up photographs, the lower tilting section which was made 2' long (but which can be made longer if a higher tower is desired) is constructed of three pieces of 1¼ inch O.D. x 16 gauge wall seamless steel tubing welded to an angle iron framework made up of 2 x 2 x 3/16 inch steel angle iron. Three pieces of 1 x 1 x ⅛ inch angle iron are used as horizontal braces and three pieces of 1 x 1 x ⅛inch angle are welded between the tubing and the 2 x 2 x 3/16 inch angle framework as diagonal braces. The three tubing legs of the lower tilting section are drilled to match the holes in the F tower section with which it mates. The angle iron framework was clamped together and welded first. The three 2' long legs were then bolted in place on the F tower section and welded to the angle iron framework. The 1 x 1 inch angle braces were welded in place last. When welding is finished it is advisable to mark one of the mating tower legs with tape, or in some other manner, for ease of later alignment when the sections are reassembled.

The upper tilting section is a 2 x 2 x 3/16 inch angle framework welded to three five foot lengths of 1¼ inch O.D. x 16 gauge wall seamless steel tubing. Three pieces of ¾" black pipe 10" long are inserted three inches into the upper end of the 1¼ inch tubing and plug and seam welded in place. The ¾ inch pipe fits inside the lower end of the E tower section with which it mates and two ⅜ inch holes are drilled in each piece of ¾ inch pipe to mate with the holes



SECTION 500F 20" x 10' | SECTION 500E 16"-20" | SECTION 500D 16" | SECTION 500C 11½"-16" | SECTION 500B 11½" | SECTION 500A 11½"

Fig. 2. Typical TV tower sections available.

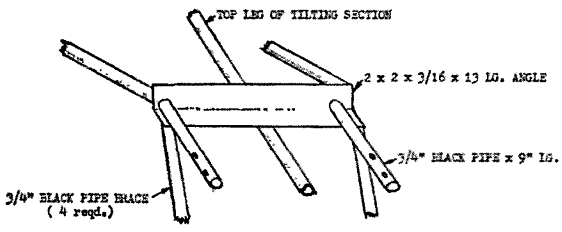


FIGURE 3

Fig. 3. The 2X2 cross angle is braced to the lower tilting section legs by four pieces of ¾ inch pipe.

in the E tower section. The holes in the pipe are drilled prior to welding the pipe to the 1¼ inch tubing.

1½ x 1½ x ⅛ inch angle is used as cross bracing on the upper tilting section. Twelve 19⅝ inch long pieces are required, spaced at approximately equal intervals along the 5 foot length of the tubing. The sequence of assembly of the upper tilting section members is as follows: As a first step the 2 x 2 angle upper framework is first clamped to the 2 x 2 angle framework of the lower tilting section for alignment since these two sections butt together when the tower is in the erect position. The four angle iron members which form the upper framework are then welded together. The three pieces of ¾ inch pipe are next welded into the 1¼ inch tubing (5 foot long) legs being careful to end up with three legs of the same length (5′ - 7″ lg.). One ¼″ diameter plug weld is used on each leg to hold the pipe in place in the tubing and then a weld bead is run around the circumference of the end of the tubing, thus joining it to the pipe. The three legs are next bolted to the E tower section and clamped to the 2 x 2 angle iron framework. The F tower section should be bolted to the lower tilting section and the entire assembly consisting of the F tower section, lower tilting section, upper tilting section and E tower section blocked up into alignment for tower straightness before welding the upper tilting section legs to the 2 x 2 angle framework. A simple and yet effective means of checking straightness is to stretch a piece of string from one end of the assembly to the other on all three faces of the tower section setup. After aligning, butt tack weld the 1¼ diameter legs to the 2 x 2 angle framework. With the setup still in place, tack weld the 12 horizontal braces in place on the 1¼ tubing legs. The E and F tower sections used for alignment can now be removed and the upper tilting section moved around for easiest finish welding positions.

The boom used for tilting the tower consists of one A and one B tower section bolted together. The B section of the boom attaches to the tilting section at two points. The upper end of the boom bolts to two 9″ long pieces of ¾ inch pipe which are shown in **Fig. 3** welded to a 2 x 2 cross angle which is in turn welded to the tilting section leg opposite the hinged side of the tilting secton. The 2 x 2 cross angle is braced to the lower tilting section legs by four pieces of ¾ inch pipe, shown in **Fig. 3.**

The boom is fastened with U bolts to the 2 x 2 angle framework of the tilting section as depicted in **Fig. 4.** Two clamps as shown in **Fig. 4** are required. The 1¼ x 1¼ angles space the boom out from the tower so that the winch can be attached to the lower part of the tower adjacent to the end of the boom. In setting up to weld the boom supports to the tilting section it is suggested that the A and B boom sections be bolted together and blocked up in place on the tilting section. The prefabricated clamps of **Fig. 4** are set in place and the boom aligned with the lower tilting section and F tower section before tack welding the boom supports. With tack welding complete the boom can be removed and welding completed in the easiest positions.

The B boom section as purchased is not strong enough in bending for use as a boom member and must be reinforced by means of a piece of ¾ inch black pipe, ¼ x 1 steel spacers and five ⅜ diameter tension members as shown in **Fig. 5.** As shown, the ¾ pipe extends across the A and B section joint and is bolted to the A section of the boom by two ⅜ inch bolts. One loose piece of 1¼ O.D. x 16 gauge tubing completes the

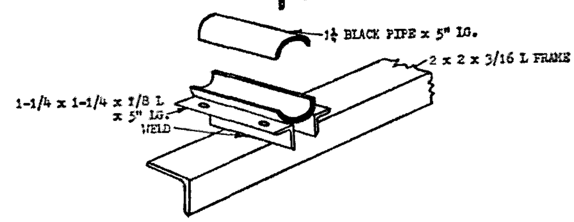


FIGURE 4

Fig. 4. The boom is fastened with U bolts to the angle framework of the tilting section.

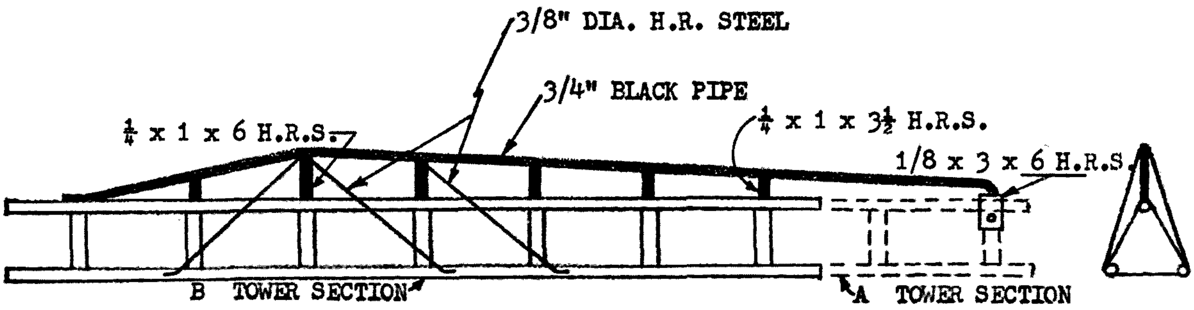


FIGURE 5

Fig. 5. Reinforcing the boom for greater strength.

boom. This tube bolts between the end of the B section and the E tower section to serve as a tension member as can be seen in **Fig. 7.**

Two hinges are welded to the front face of the 2 x 2 angle frameworks of the upper and lower tilting sections. One hinge is shown in **Fig. 6.** A ⅝ diameter bolt serves as a hingepin.

A Sears Roebuck double rachet boat winch costing $5.99 is adequate for tilting the tower. The winch is bolted to a plate which is fastened to the tower leg by U bolts. The winch rope is ⅜ x 30 foot long polyethylene. ³⁄₁₆ diameter steel winch cable can be used alternately.

Erection of tower

Select a site having clearance for the tower and boom to raise and lower. This may be a problem, what with telephone wires and trees. The author's tower is set next to a ranch style house and the tower lowers across the roof so that one stands on the roof to work on the antenna. The tower should be set in a concrete base a minimum of 24 x 24 x 36 inches deep. Set up two F sections and the lower tilting section bolted together and block in place over the base hole. Set a plumb bob up, level the tower and leave the plumb bob in place while the concrete is poured to make sure the tower stays plumb. Let concrete cure for a couple of days and then set the guy wires. Use either 2′ x 2′ x 1′ deep concrete blocks set 3′ below ground level for guy anchors or 6″ screw type anchors such as are available from Sears Roebuck & Co. Tension guys to equal pretension of about 300 lbs. Proceed with erection of remainder of tower and boom using either extension ladders or a gin pole. A gin pole is a simple pipe and pulley arrangement which can be clamped to the tower section already erected so that the next tower section can be hoisted up to the man who is setting the sections. Use a safety belt in standing directly on the tower during erection. Once the upper tilting section is in place you can alternately attach a tower section and a boom section while tilting the tower back and forth. This tilting procedure limits tower climbing to the twenty foot level, which helps the safety problem.

Guying

The 65′ tower as described herein will safely withstand 87 mph winds carrying an antenna load such as a small three element Yagi-Uda or 2 section Quad beam when guyed with three ¼-inch diameter high strength guy wires attached to the tower just below the tilting section and anchored to the ground 22 feet out from the tower. (No comment is offered relative to survival

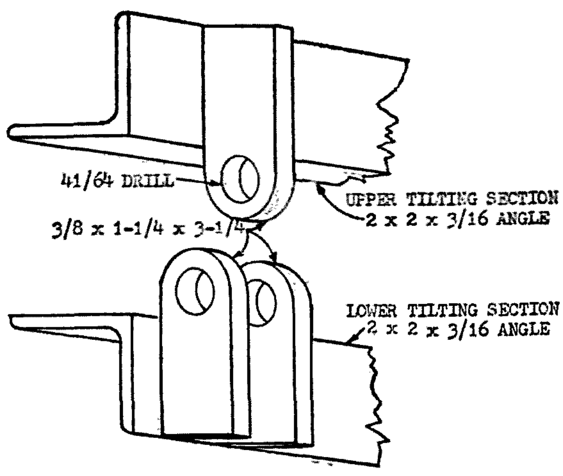
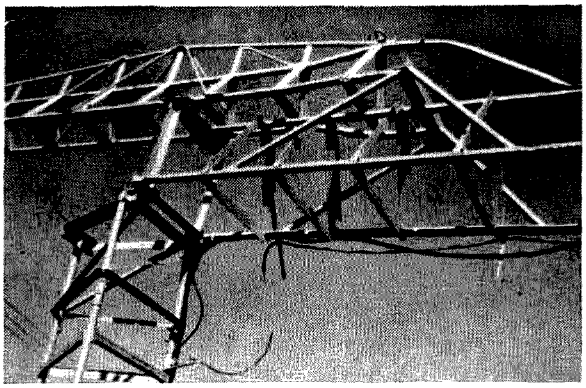


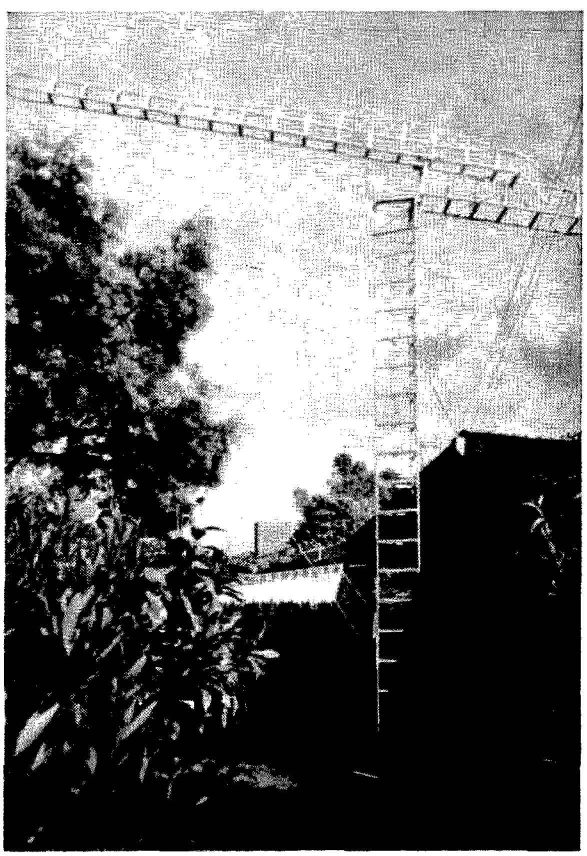
FIGURE 6

Fig. 6. The hinge assembly for the tilting tower.



Close-up of hinged section

of the beams.) If a large beam such as a four section quad (9 sq. ft. wind load area) is used, three ¼-inch diameter high strength guy wires attached 50′ above ground and at least 25′ away from the base of the tower at ground level will be adequate for 87 mph winds. (An 87 mph wind imposes a 30 pound per square foot load on the tower and antenna.) However, since the tower can be tilted down in a few minutes, it is logical to do so if hurricane velocity winds are anticipated. In a reasonable amateur installation where the tower is tilted down during severe wind storms, this tower carrying a 9 square foot antenna wind load and guyed with three ¼ inch diameter high strength guy wires attached just below the tilting section is adequate for 65 mph winds.



The completed tower in action

Welding

If you like to build, it is recommended that you buy one of the low cost arc welding units on the market, learn to weld, and do your own set up and welding on your tower. This was the author's method. With the contact rods available today, anyone can learn to run a strong weld bead in a few weeks of spare time practice. The welding and technique, incidentally, are invaluable in building antennae and many other things. Reference 2 is suggested for the beginner welder. Use 7014 welding rod for all of the tower welds.

Another variety of the tilting tower, which is incidentally stronger than the tower described, is to use three F tower sections below the lower tilting section and one each of the A, C and E sections above the upper tilting section. This has one disadvantage, namely, the end of the boom is now 15 feet above ground level instead of 5.5 feet. With the boom elevated, a pulley can be installed 15 feet above ground on the tower and the winch cable run from the end of the boom over the pulley and straight down the side of the tower to the winch. Still another variation which results in a 76 foot high tower is to build the tower as described, except use three F sections below the tilting section instead of the two F sections used by the author.

One last thought. If this all sounds like too much work and if you will be satisfied with a fixed tower, the Jontz tower is an excellent low cost unit, 60 feet for $141.00.

. . . W6DL

Ref. 1. Jontz Manufacturing Co.
1101 East McKinley Avenue
Mishawaka, Indiana

Ref. 2. *New Lessons in Arc Welding* (The Lincoln Electric Co.; Cleveland 17, Ohio). Price: $1.00

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

A 40 Foot Non-Conductive Sky-Hook

Paul E. Peterson K7VBQ
P.O. Box 741
Gila Bend, Arizona 85337

"A" Frame masts with the necessary guy wires are functional, but require lumber, hardware, and a bit of carpentery skills. . .

TV masts will suffice for Field Day Doublets, but won't pack the weight required for the average Amateur antenna. . .

I enjoy dreaming over pictures of 60 foot tilt-over metal towers. . . *dream,* that is.

Most "Joe Average" types are resourceful and Hams are no exception, have you ever seen a 20 foot piece of half inch waterpipe tied to a treetop with a pulley on the end to raise an 80 Meter dipole?

In the November '65 issue of 73, Earl Spencer K4FQU described his 80 foot telephone pole installation. It is interesting and serves as a good reference for this article.

Still, 80 foot poles don't grow on trees, so to speak, but there must be enough of the little ones around to equip every ham with at least one.

My problem is twofold. First, my station is located in a trailer park with not much more than room for a trapped vertical and possibly a VHF beam. Second, being a fringe T.V. area, it is almost a necessity to keep below 20 meters as the cleanest rig will block out the weak TV signals.

The only advantage is that every TV receiver must have an external antenna and mast or pole. It isn't too hard to sneak in a ham-band antenna with a little ingenuity.

To get on with it, no station is any better than it's antenna system, and the lower bands get short-changed because of the size required for a good half-wave dipole or quarter-wave vertical without a lot of messy guy wires.

I was fortunate to obtain a like-new utility pole from a friend, with the prime purpose of raising the wife's TV antenna higher for better reception, I told her. Of course I may have harbored a few thoughts for a ham antenna or three!

What can a Ham do with a nice big hunk of free-standing sky-hook? Well. . .

First it has to be brought home, and to say the least, this is no small obstacle. In fact, since it is the first of many, it is the

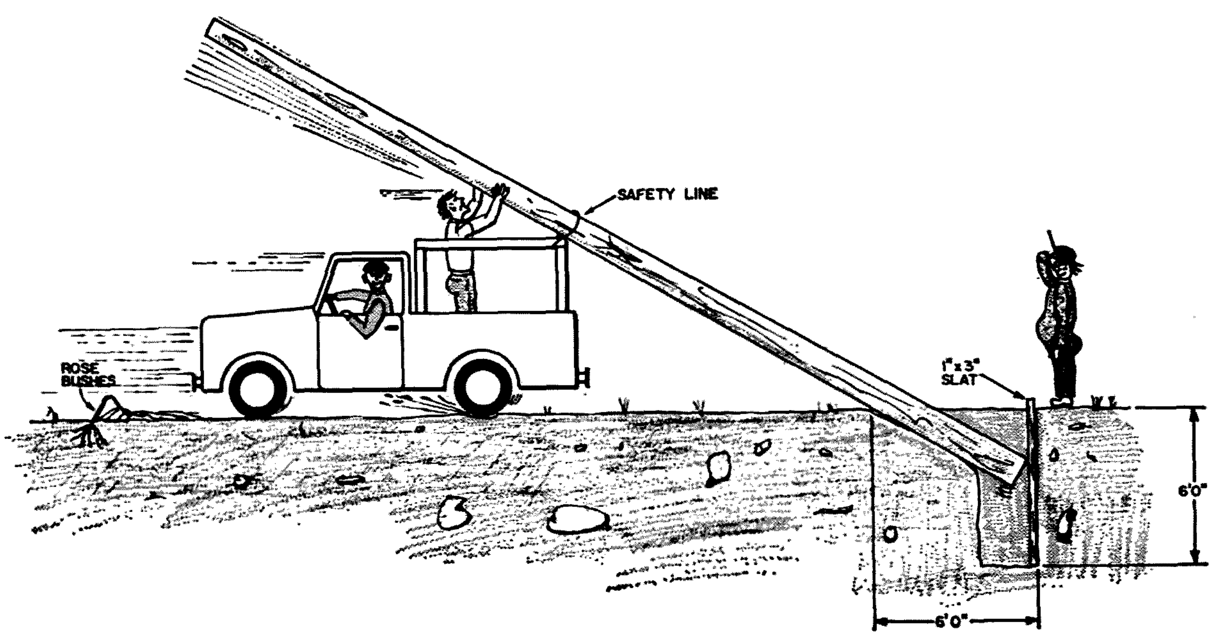


Fig. 1. Easy does it. Actually it is simple. Just make sure the driver is sober!

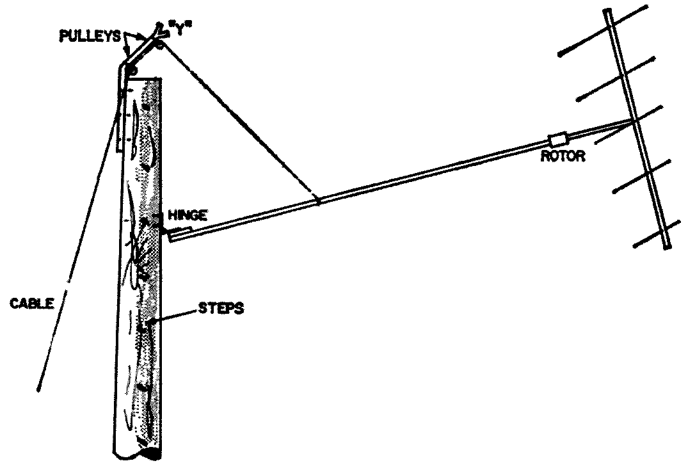


Fig. 2. "Tilt-over" for UHF beams. Great for the VHF beams of under six elements, 6 meters that is.

hardest. When you find the answer to the problem, any that follow will seem to be easier.

Having less than 2500 men, women and pets in town means I have to rely on "unskilled" labor. To recruit help I use the brew method, and rate all tasks by the six-pack or case. Hollering, "Pole Party at Peterson's house," will bring enough backs to get the job done. If there are high school athletes around, so much the better, cokes and snacks are cheaper.

Take a Pole

Finding a pole in Arizona is not difficult. Farms ranches and small towns seem to have an abundance of them scattered around. These can usually be had for little or nothing, depending on your tact.

If these means are not available, try the utility company. they usually have poles that have been replaced for one reason or another but are still sound. You may have to shell out a few pesos and sign a release, but it should be nominal. New poles of 30 or 40 feet in length usually run about a dollar a foot, and a used one will run in the neighborhood of ten to twenty dollars, if you can't get it for your good looks.

Add One Hole

Prepare the "pole hole" before bringing the pole home. Storage creates a problem.

For depth, I was told that one fifth of the pole should go in the ground, but that is for utility service, all those wires have a lot of wind drag. If the soil is sandy it should be no less than seven feet deep.

The soil here is dry, but hard as rock. I buried my pole six feet, and with proper tamping, it turned out like it grew there.

The diameter needs only to be about 12 inches larger than the pole's diameter for this method, versus several feet larger when using a boom truck.

Slant the hole on the side you intend to erect the pole from, as in **Fig. 1.** With the hole slanted, there will be more of the butt in the ground, sooner. Also, less dirt will get peeled off the near-side of the lip, and there will be less jerking as you near the upright position.

Bring Together

Since the pole was mine for the taking, I had to devise a plan to get it home. All of three miles and across a U.S. highway.

A trailer used for hauling a jeep to the back country was the answer. The trailer was towed to the pole, facing the top end and about in the middle.

Three of us lifted the light end over our heads while the fourth man wheeled the trailer under the butt end as far as it would go. When we lowered it down the pole was balanced just right for towing. We secured the pole to the trailer hitch and the rear cross member with ¾ inch nylon rope.

To fasten the cludge to the vehicle, a ball socket should be attached to the light end with bolts or large lag screws.

We took a heavy chain, and with a clove hitch around the pole and a loop around the ball, were about ready to go. To further secure the chain, we put ⅜ inch bolts through the links to hold the chain securely.

It didn't slip, but this method isn't ad-

vised, Mr. Law becomes unhappy with such practices.

Don't forget to hang a red flag (or shirt) on the rear of your semi-pole, and, if possible, have someone follow with four-way flashers.

This operation cost the better part of a half case of Rocky Mountain Water, consumed back in the safety of the yard.

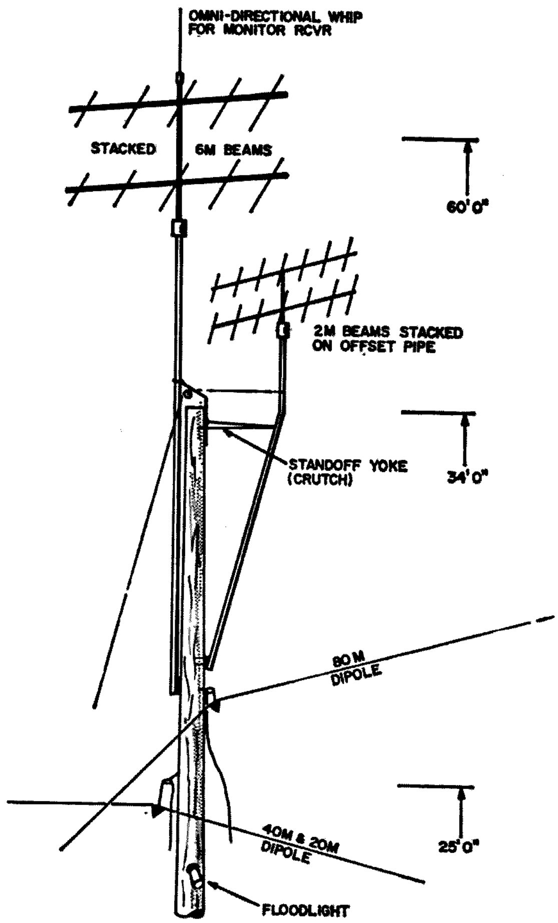


Fig. 3. Why not?

Garnish With Steps

Now, before you try to get that son-of-a-gun airborne, consider "stepping" it now. (Steps?) You are gonna hafta climb it, like it or not.)

We drilled ⅝ inch holes for the steps, but, again not thinking too far ahead, listened to experts. It may take an extra fifteen minutes to set a pole with the steps installed, but it is much easier than a two hour stint later.

The holes are drilled three feet apart on a side and staggered from side to side to form 18 inch steps.

A sledge hammer is used to drive the steps in almost to the marking ring located about three inches from the threaded tip. Then the step is screwed in a couple of times to seat it.

Oh, one small detail, scrounge up around fifteen steps or reasonable facsimile unless you are adept with climbing hooks.

On good advice, I borrowed another friend's belt and hooks and such a hair-raising ordeal I never had! It was the first, and I hope the last time for that scene. Unless you have used hooks before . . forget it . . .!

Double stepping approximately five, and again at six and a half feet from the top makes working up there much simpler and safer. If your feet aren't on the same level you will get darn tired fast.

Climbing with steps is tolerable, but a belt of some sort is still necessary to free your hands safely.

Combine Ingredients

Now to put your pride and joy up where the neighbors can admire it, in all it's splintery splendor.

We placed the butt over the hole, with the pickup at the other end. A couple of 1 x 3 inch slats were placed against the back of the hole, to keep the pole from hanging up and gouging dirt into the hole.

While two of us held the pole up, the third man backed the truck under far enough for us to place the pole on a sturdy pipe or ladder rack installed on the back of the pickup. From then on it was smooth sailing. With one man at the butt, and one in the back of the truck, the third man moved the truck back VERY slowly, a few inches at a time.

The man in back kept the pole from moving sideways, while the man at the butt kept it feeding properly by kicking it down, as it had a tendency to bind on the slats.

A roller of some sort on the rack would be desirable, and would make the operation a lot smoother, but isn't necessary.

After the pole is elevated to 45 degrees, it starts to get top heavy and much care need be taken. A loose loop of line was tied to the rack, around the pole, and again tied to the rack. This allowed the pole to move upward on the rack, but would have snubbed it if it had tried to go to the side. Remember, SLOW . . . Keep it centered at

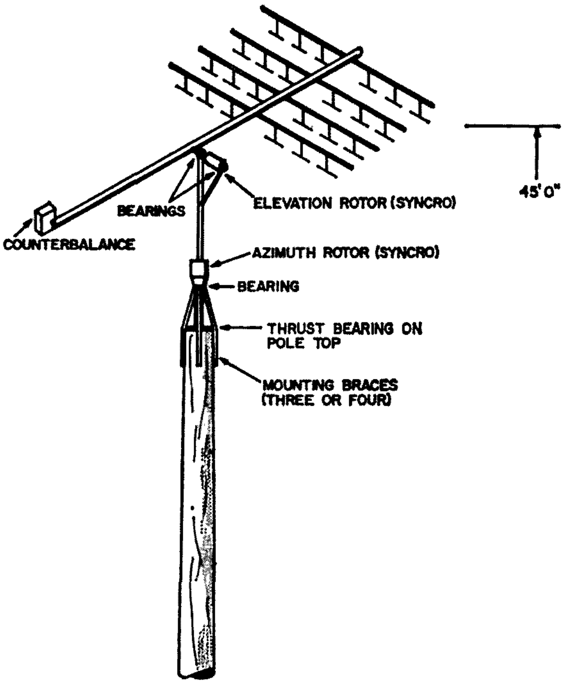


Fig. 4. Moonbounce, anyone? Eliminate the counterbalance by making the array larger and putting the elevation rotor in the center!

all times. If that beast gets away, something is going to get bent . . . and bad!

Keep the truck against the pole when it is vertical, and cinch up the snubbing line. Two men can hold the pole vertical while the third shovels in dirt. Pack it solid now and no loosening will occur.

One shoveling and three tamping is the rule. Tamping cannot be overdone! With a foot or so of loose earth around the pole, use a tamping bar or pipe until your arms ache. Add more dirt and repeat. Doesn't that brew taste good?

The tab for this part of the pole party came to one case, most of it lying on our backs and admiring our handy-work.

To thwart would-be Tarzans, there shouldn't be any steps below 7 or 8 feet. There are removable steps that hang on lag bolts screwed almost flush, but if they aren't available, you can use regular steps and remove them when not in use.

To enhance the appearance of your new marvel, try painting the first 6 or 7 feet white, and, if you have a feud going with the lid next door, continue on up with red and white, alternately.

Attaching Antenna Masts

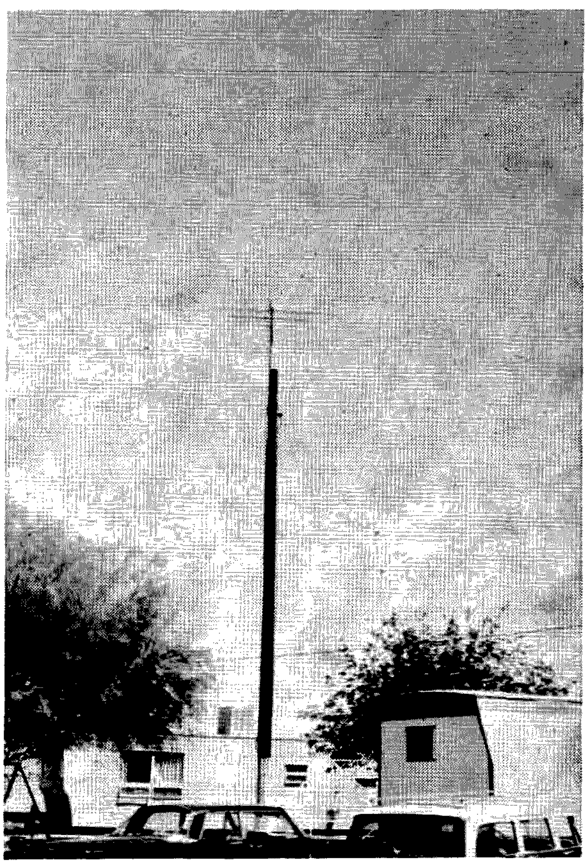
Now that the pole is up it is useless without a few antennas hanging from it. I won't elaborate on methods of mounting antennas of this type of pole. The variables of location, band requirements, and the individual Amateur's tastes are many and would require many pages of print. There have been numerous articles for specific installations so I will briefly cover a few which have struck my fancy and may stimulate your imaginations.

By looking at K4FQU's article in the November issue of 73, and another in the ARRL Antenna Book dealing with a 60 foot tilt-over made of will casing, you should be able to come up with a few ideas for mounting the larger 10 thru 20 meter beams, VHF collinear arrays and such.

For VHF beams, **Fig. 2** will be more than adequate. This installation works well for the larger TV Yagis around town and we get some fairly powerful dust storms.

All that is needed is a 6 foot piece of heavy angle iron, a pair of large pulleys, barn door hinge, a 10 to 20 foot piece of 2 to 2.5 inch water pipe or equivalent, and some large lag bolts.

If need be, K4FQU's latch arrangement can be incorporated, or the angle iron can



Painting the bottom part to match the background helps to make the pole disappear?

be bent as shown, and a "Y" attached to cradle the mast when it is upright.

The hinge should be located down from the top of the pole a distance equal to at least one third the length of the pipe and antenna support.

The cable should be attached to the pipe at the point that is directly opposite the upper pulley when the mast is upright.

The hinge is welded to the pipe and attached to the pole with large lag bolts, with the hinge being closed when the mast is up.

With this arrangement antenna adjustments or experiments will be simplified.

For a full quarter-wave 80 meter vertical I have only a start at the present, an old trapped vertical with the traps removed. The top of the vertical is 63 feet above the ground. I plan to bring heavy copper wire down from it's base, (bypassing the insulator) to one foot off the ground.

With proper radials it should load easily. Tuning will be with an SWR meter and a sliding tap.

I will cover the lower 8 feet with a piece of wood or fiberglass molding to prevent the possibility of someone getting an rf burn. (Leaving the base of the molding open for drainage.)

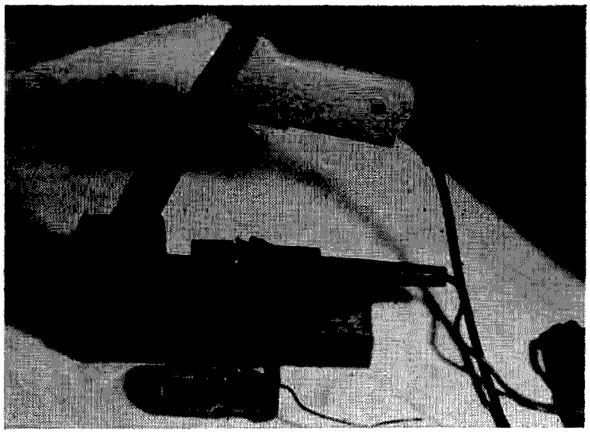
With a 2 x 4 and 2 x 2's laid across the top of the pole it would be possible to construct a "Lazy H" from a pair of 40 meter inverted "V"s suspended from the ends.

The possibilities are endless, take a look at **Fig. 3.** If that doesn't start you looking for a pole for your backyard, I wish you luck on your cross-town DX. Hi!

I got a bit carried away with **Fig. 4,** but the moonbounce boys can have a ball with this idea. With all the expensive receivers and arrays needed, the added cost of a tower has squelched a few would-be moonbouncers.

I hope to see a few new poles around with all types of goodies sprouting from their tops. If I can be of more help, I will answer any questions if at all possible. I'm in the book. . . . K7VBQ

Burn Prevention



This soldering iron/pistol stand has been used at VE3BUE for several months without any burns!

How often has that soldering iron of yours burned you? Getting tired of cursing the blasted thing? I solved the problem by building a small "cage" type stand so that even if I did accidentally touch the stand I could not get burned.

As shown in the photograph, my stand holds two irons. The base is a piece of scrap pine. The stand for the pistol is made from an old loudspeaker back that used to hold the coil and magnet together. The spring can be replaced by a piece of pipe with plenty of holes drilled into it. The small iron has a homebrew bracket as shown in the photo.

In case you are worrying that the weight of the pistol will topple the stand, don't! The pistol is of German manufacture and weighs less than most irons. If you do use a transformer type soldering gun with this stand, the base will either have to be made larger or else bolted to your workbench.

D. E. Hausman VE3BUE

William R. Hirt W7GBJ
1019 S.E. Roberts Ave.
Roseburg, Oregon

The Beam Pole

The beam pole has a number of features not possible with other means of supporting a beam antenna. A beam can be lowered in a horizontal position to within 7 feet of the ground if a wind storm threatens or if work on the beam or rotor is necessary. Since it can be run up and down the pole in minutes, the beam can be moved to any desired height for testing.

The pole should be set so that the beam is clear of obstructions. Dig a hole 4½ feet deep and large enough to receive the pole; place the butt at the edge of the hole and with the pole along the ground. It can be of any length but should have a 5 to 6-inch cross section at the top. A suitable pole can usually be purchased from your telephone or electric company for about $60.

Snap a chalk line the full length of the pole so it can be used as a reference mark. Trim the top of the pole so that a sheave housing can be fastened with lag screws. About 1 foot from the top, make two saw cuts 2½ inches apart, 1¼ inches deep, across the chalk line. Chisel out the wood between the saw cuts and smooth it out. Place one of the angle irons in the slot and bolt it through the pole with a ½ inch bolt. Do the same with the other angle iron about 2 or 3 feet above ground level at the butt end of the pole. Be sure that both top and bottom angles are in line.

Cut two pieces of ⅜ inch galvanized guy wire about 2 feet longer than the distance between the top and bottom brackets. Insert one end of each cable through the ½ inch outer edge holes in the top bracket and bend the ends back about 2 inches and fasten them securely with ⅜ inch cable clips. These clips should act as cable stops on the top side of the bracket; until the pole is erected the lower ends of these cables can hang free.

Run the 3/16 inch aircraft cable through the sheave and fasten the ends near the lower bracket temporarily with staples.

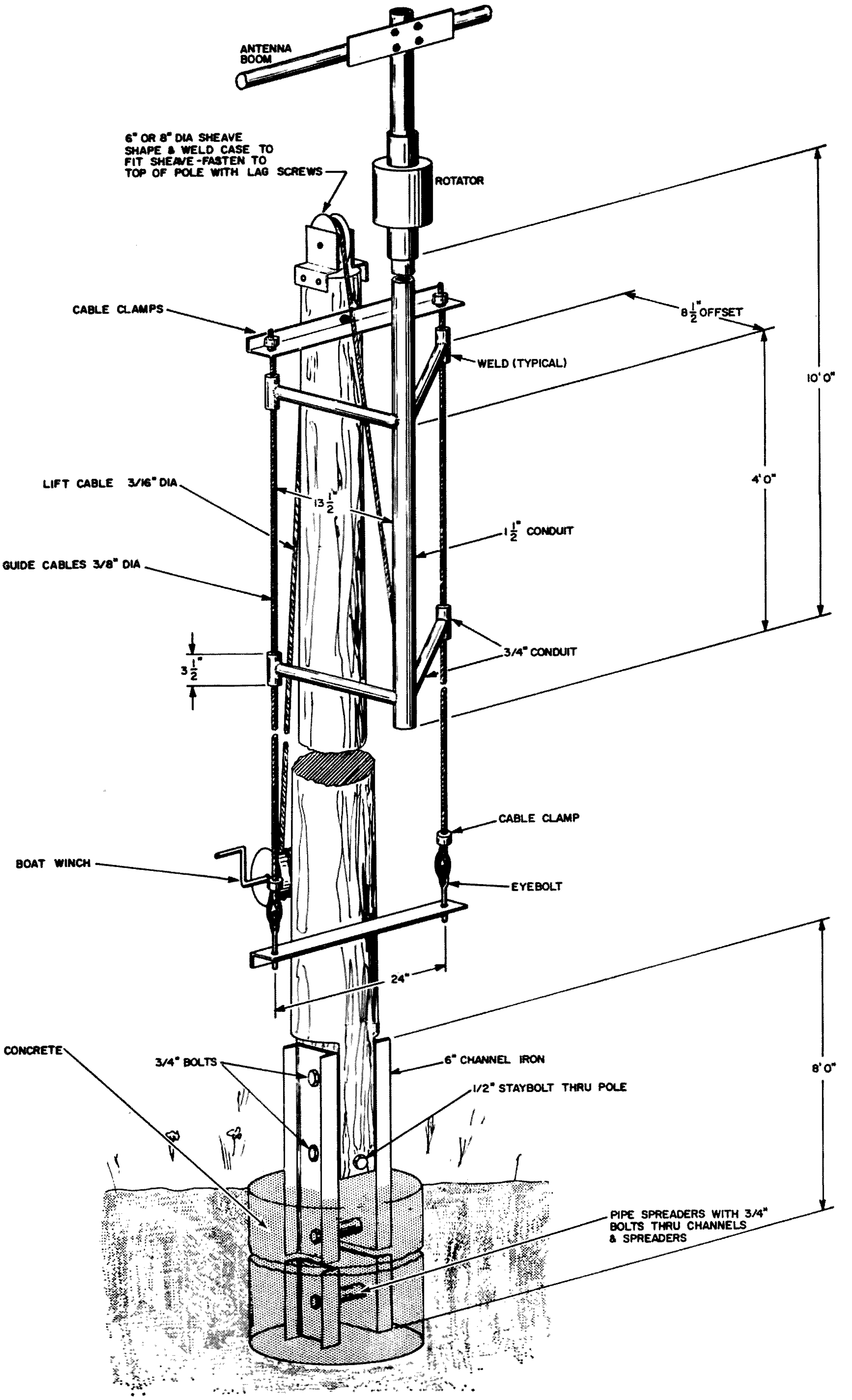
If the pole is to be set in the hole, the ground portion should be painted with some preservative, and the pole should also be painted. Setting the pole is a job for a telephone or electric company crew. They will usually do the job quickly for a reasonable price.

A hinge base for a pole, similar to those used on some flag poles can also be used. (See diagram for details). With a tilt-over installation, the pole can be raised with a car or truck, using a cable and a gin pole or crotch made out of two pieces of 2" x 8" x 14' long.

When the pole is set, you can tie the sliding frame to the pole several feet above the lower angle bracket. The two ⅜ inch guide cables can now be threaded through the upper and lower guides on the sliding frame. Place the ½ x 8 inch eye bolts in the ½ inch holes at the ends of the lower angle bracket. Pass the cables through the eyes. Pull the cables as snug as possible by hand. Bend the ends up in a tight, close loop and secure with ⅜ inch cable clips. Cut off the surplus ends of the cable. By using an iron bar or wrench to hold the eye bolts from turning, tighten the nuts on the eye bolts until the cables are tight; alternate the tightening between the eye bolts to keep the top and bottom angle brackets parallel.

Select the desired height from the ground and bolt the boat winch on the back side of the pole. Loosen the staple holding the back half of the 3/16 inch pull cable and fasten the end securely to the cable drum. Now loosen the staple holding the front half of the cable, pass it through between the guide arms of the sliding frame and fasten it to an eye that has been welded to the low end of the mast. Use one or two 3/16 inch cable clips. Wind the cable on the winch and raise the slide frame about a foot.

You are now ready to mount the rotor and beam on the 1¼ inch mast part of the sliding frame. Connect the feed line and set the beam so that it is parallel with the top bracket. This is necessary so that the beam can pass the top bracket. The beam will extend above the top of the pole by about six feet when it's pulled up so that the top of the guildes will hit the lower side of the top bracket. Give an extra pull with



ANTENNA BOOM
6" OR 8" DIA SHEAVE SHAPE & WELD CASE TO FIT SHEAVE-FASTEN TO TOP OF POLE WITH LAG SCREWS
ROTATOR
CABLE CLAMPS
8 1/2" OFFSET
WELD (TYPICAL)
10' 0"
4' 0"
LIFT CABLE 3/16" DIA
13 1/2"
1 1/2" CONDUIT
GUIDE CABLES 3/8" DIA
3/4" CONDUIT
3 1/2"
CABLE CLAMP
BOAT WINCH
EYEBOLT
24"
8' 0"
CONCRETE
3/4" BOLTS
6" CHANNEL IRON
1/2" STAYBOLT THRU POLE
PIPE SPREADERS WITH 3/4" BOLTS THRU CHANNELS & SPREADERS

the winch, so the pawl will engage the next notch to insure rigidity.

You now have a very satisfactory beam installation. No guy wires are needed and your beam can be lowered in a hurry for any reason. . . . W7GBJ

Material list

1 pole 5 to 6" cross section at top; length as desired.

2 pieces ¼" x 2½" x 2½" angle iron 26" long, ½" hole drilled at each end on 24" centers, ½" hole in center on opposite angle 13" from end.

⅜" galvanized guy line cable, to reach top and bottom brackets plus 2' for fastening.

3/16" air craft cable long enough to run from eye at bottom of mast through sheave at top and down to winch.

1 7" or 8" "Vee" belt pulley, ½" hub.

1 pulley housing.

8 ⅜" x 3½" lag screws.

4 ⅜" cable clips.

2 3/16" cable clips.

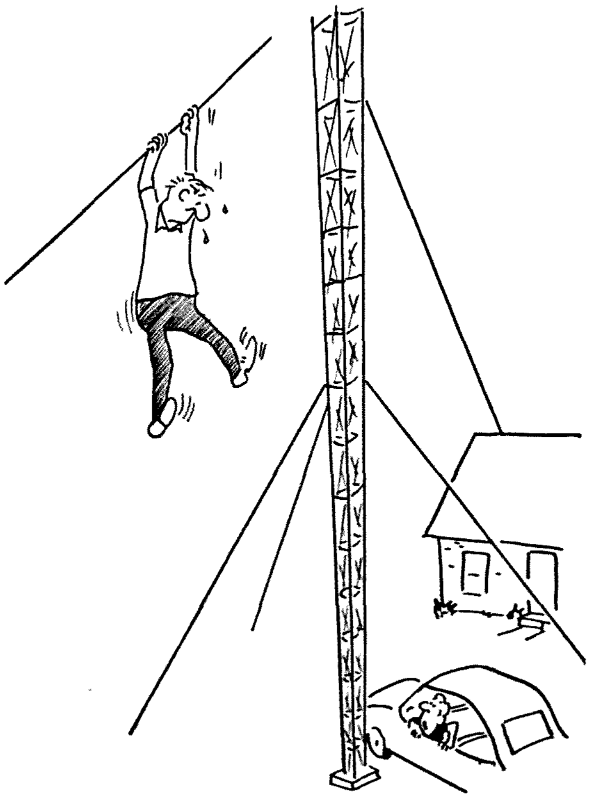
2 ½" x 8" eye bolts.

1 piece 1¼" x 10' thin wall conduit.

1 piece ¾" x 6' thin wall conduit.

1 ⅜" x 6" or 7" bolt and washers.

1 ½" or ⅝" x 12" or 14" bolt and washers



They didn't have any 20 foot Ladders at The Hardware Store, do you want me to try the Radiostore?

Scott Marovich
2407 S. Rose St.
Kalamazoo, Mich. 49001

Electricity Abroad

A handy reference for hams vacationing or traveling, and planning to operate overseas—or for anyone planning a DXpedition—is a new booklet prepared by the Department of Commerce, in co-operation with the U.S. Foreign Service, "Electric Current Abroad." Originally published in 1963 for use by U.S. manufacturers, exporters, and citizens living or traveling abroad, this 81-page revised edition has been expanded and updated to include a current list—arranged alphabetically—of the characteristics of the electric power supplied in most of the major cities and countries of the world.

The list includes the type of current (ac or dc), nominal line voltage and (if ac) frequency, phase of the system (single- or 3-) and the number of wires (2, 3, or 4). Frequency stability and freedom from service interruptions are indicated by "Yes/No" evaluations of whether electric clocks may be used reliably, and special wiring conditions such as "neutral" third wires are also noted. The list includes only the power supplied for domestic or light commercial service, and does not cover industrial, high-voltage, or other special applications. Also included are illustrations of the three types of plugs and sockets most commonly in use around the world, and an accompanying table showing, country-by-country, which are used where, and whether adapters are readily available.

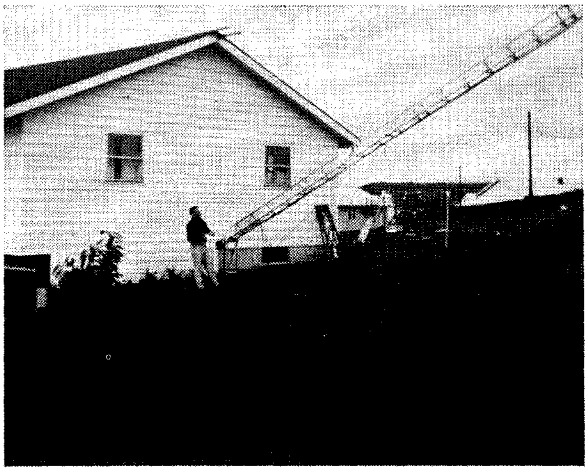
Aside from being a valuable reference, "Electric Current Abroad" is also an interesting source of general information and, should you be so inclined, and aid to settling pointless arguments. A few salient facts, for example:

Aside from Argentina, Greece, and India, which seem to have mixed ac and dc systems, only a handful of major cities still rely on dc. Glancing down the list, I was unable to find a single ac system with a nominal frequency other than 50 or 60 Hz (50 having a slight edge over 60), although there seem to be quite a number of places where the stability or freedom from service interruptions are less than perfect (Northeast U.S., perhaps?). As in this country, most cities offer a single-phase voltage in the neighborhood of 110-130 v, and 3-phase power of 190-250 v, although a large number supply 190-250 v, single-phase, and 380-460 v, 3-phase. Some cities offer all three voltage ranges, and, going down the list, one can generally obtain all the possible permutations of voltage and phase, with some cities even offering one voltage range in ac and another in dc!

All in all, "Electric Current Abroad" is an interesting and valuable source book, especially considering the price (which we naturally saved until the end, to entice you): It's only thirty cents, postpaid, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Specify Cat. No. 0 265-525 when ordering.

Tilt That Tower

Dennis Bryan W2AJW
4 Crescent Drive
Apalachin, N.Y.



Tower on the way down with helpful neighbor demonstrating the use of the restraining lines.

How many times have you read "beam antenna" construction articles and thought that you would really like to give it a try—except—how would you get it up on top of your tower. And right there you drop it and just keep on dreaming about 8.5 or 10 or 11 db gain—how it sure would give that extra punch to that rig you have.

Let's face it, no matter how good a rig you have, if you aren't radiating maximum you're not in good shape to compete for that rare DX.

So, if you can't afford a crank up tower, don't have a crane handy or can't muster up enough extra pairs of muscles whenever you want to work on the beam, then this article is for you.

Right now let's quench your fears of special parts, welding, etc., before we go on. Everything used in this project can be found in Sears Roebuck and Co., and a moderately stocked steel supply house. The actual conversion will depend on the type of tower you have, but the basic principle will remain the same.

There is one requirement with this type of construction article that should be kept in mind—be very critical of so called "junk-box" parts. Don't skimp on the quality of the material you use. You are dealing with considerable weight and a component failure could be catastrophic. No matter how confident you are of the finished product never allow anyone to stand under the tower when you are raising or lowering it!

The actual conversion will depend on the type of tower you have and for that reason actual dimensions will not be given. However, using my conversion and pointers as a guide, you should be able to do a safe and lasting job on your tower.

My tower was manufactured some 12 years ago, is 50 feet high, has one inch tubular legs on 12 inch centers and has horizontal braces also made of one inch tubular steel. This type of construction was typical for that era and compares with the newer towers using solid steel "zig-zag" or flat "corrugated" bracing.

The tower conversion can be broken down into four steps once you make sure you have enough room on *your* property on which to lay down the tower.

1. Construct a base hinge.
2. Construct in intermediate pulley mount.
3. Determine the weight to be lifted.
4. Select a proper cable, winch, and pulleys.

Construct base hinge

The base hinge should be constructed one or two feet above the ground. Putting the hinge at that height will allow the winch to be mounted on the tower, eliminating the problems of mounting it on the house. The hinge should not be made any higher than two feet from the base as the thrust of the tower in the horizontal position may cause the vertical portion to bend. Examination of the photo will show the two 1¼ angle brackets that were added between the hinge and lower rear base for that reason.

The hinge itself is constructed by cutting the tower in two, midway between the horizontal supports, about one or two feet above the ground. Two pieces of 2 inch angle iron are bolted horizontally to the front legs. Two ⅜ inch bolts are used in each end of each piece of angle iron. A 1¼ inch length of angle iron is bolted to the rear of the lower front legs under the lower of the two ⅜ inch bolts. The 1¼ inch angle support brackets mentioned earlier are bolted at the upper end to this 1¼ inch

angle iron. The lower ends of the 1¼ inch angle irons are bolted to the lower rear horizontal support member. The hinges are of the "Barn-door" variety from Sears Roebuck and Co. and are held to the 2 inch horizontal pieces by ⅜ inch steel bolts. Use the largest hinges that will fit your tower width.

The hinged section of the tower can be made stronger by inserting 18 inch steel rods or pipe into the hollow legs or by removing about 10 inches of the legs between the horizontal members where the hinge will be installed.

The clamp for the rear tower leg is made by splitting a 10 inch piece of one inch ID pipe or tubing with a hacksaw. This clamp is held with four ⅜ inch bolts, two above and two below the cut in the leg. When lowering the tower it is only necessary to remove the top bolts.

Intermediate pulley mount

Since my tower was put up next to my house, the intermediate pulley mount was combined with a home made "house-bracket". The house bracket was made of two 2 inch by four feet lengths of angle iron. These two brackets extend approximately 21 inches out beyond the house. The underside of the roof where they are bolted is reinforced by 2 x 8 inch lumber. Just outboard of the roof of the house a length of 2 inch angle iron is bolted between the two arms. The intermediate pulley is bolted to this angle iron.

A length of 1¼ angle iron is U bolted to the inside of the front two tower legs at a height equal to the two 2 inch angle iron arms of the house bracket. When the tower is raised, this angle iron bolts to the two arms with ⅜ inch bolts.

Several of the preceeding steps require the bending of the ends of angle iron. This is easily accomplished by hacksawing the unneeded side off the angle iron and then using a hammer to obtain the required bend in the tab.

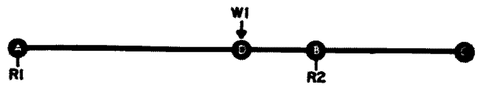
The winch is mounted on a 1½ x 3 inch "U" channel 19 inches long. A one inch hole is drilled 10½ inches from the left side of the channel. The channel is then slipped over the rear leg before the rear clamp is installed. One ⅜ inch hole is drilled through the channel and rear leg and another through the channel and front horizontal member. ⅜ inch bolts are used to secure the channel to the tower.

Determine weight to be lifted

Three or four formulas will be used to determine the tension in the lifting cable, pully and winch:

A1. Determine lifting weight of tower alone:

For uniform construction towers.



W1= Weight of tower alone (weight per section times number of sections).
AD= ½ tower length or AC/2.
R2= Point tower raising cable attaches to tower.
R1= Base or hinge pivot point of tower.

To solve for R2:

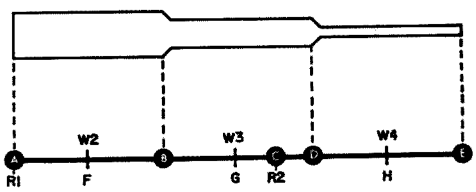
$$(AD)(W1)-(AB)(R2)=O \quad R2=\frac{(AD)(W1)}{AB}$$

To solve for R1:

$R1+R2=W1$
$R1=W1-R2$

A2. Determine lifting weight of tower alone:

For tapered tower construction such as the Spaulding "Strato-Tower".



W2= Weight of 1st section.
W3 =Weight of 2nd section.
W4= Weight of 3rd section.
R1= Base or hinge pivot point of tower.
R2 =Point tower raising cable attaches to tower.

$$AF=\frac{AB}{2} \quad BC=\frac{BD}{2} \quad DH=\frac{DE}{2}$$

$AC=AB+BC \qquad AH=AB+BD+DH$

To solve for R2:

$(AF)(W2)+(AG)(W3)+(AH)(W4)-(AC)(R2)=O$

$$R2=\frac{(AF)(W2)+(AG)(W3)+(AH)(W4)}{AC}$$

To solve for R1:

$R1+R2=W2+W3+W4$
$R1=W2+W3+W4-R2$

B. Determine lifting weight of tower, antenna, rotor, etc. combined:

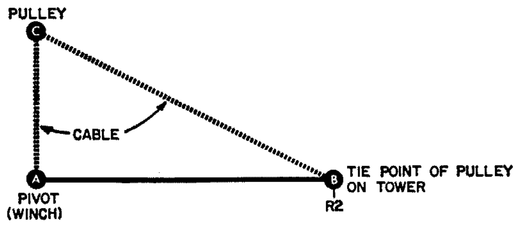
LW= Lifting weight of tower where cable attaches.
R1 and R2= From formula A1 or A2.
W5= Combined weight of antenna, rotor, etc.
AB= Distance from hinge base to lifting cable point on tower.
BC= Distance from lifting cable tie point to antenna at top of tower.

To solve for LW:

$$R1+(AB)(R2)+(AC)(W5)-(AB)(LW)=O$$

$$LW=\frac{R1+(AB)(R2)+(AC)(W5)}{AB}$$

C. Determine tension in lifting cable, pulley and winch:



R2= From formula B.
AB= Distance from hinge base pivot of tower horizontally to cable tie point.
AC= Distance from hinge base pivot of tower vertically to pulley.
T= Tension in cable ACB

$$CB=\sqrt{(AB)^2+(AC)^2}$$

To solve for T:

$$T=\frac{R2}{AC+CB}$$

Examination of the formulas will show that:

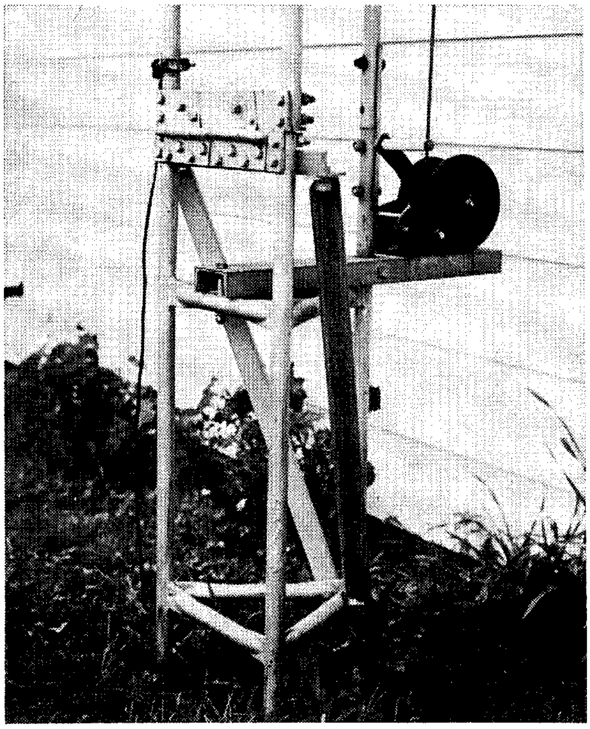
1. Establish the intermediate pulley point, point "C" in formula C as high as possible. The higher that point is the less the tension in the lifting cable.

2. Keep the cable tie point on the tower out as far as possible—at least half the tower length. The maximum distance out for the point will usually depend on the height of the intermediate pulley.

Select proper cable, winch and pulleys.

A. Cable

Steel cable (wire rope) comes in a variety of sizes, strandings and strengths. Wire rope is commonly designated by two figures, the first indicating the number of strands and the second the number of wires per strand. That is: 6 x 7 is a six-strand rope having seven wires per strand. The higher the number of strands and wires per strand the more flexible the cable. For instance a 8 x 19 cable is much more flexible than a 6 x 7 cable. Because you will be using a small (2 or 3 inch) pulley you will want a flexible cable, say 6 x 29 or 8 x 25.



Base hinge and winch mount. Note angle iron support struts going from upper front legs to lower rear leg.

The strength of cable depends upon its size, kind of material of which the wires are made and their number, the type of core, and whether the wire is galvanized or not. This table gives the medium strengths of cable appropriate for this type of application:

$\frac{3}{16}$ 2500 pounds
$\frac{1}{4}$ 4000 pounds
$\frac{5}{16}$ 6500 pounds
$\frac{3}{8}$ 9500 pounds

A minimum factor of safety of three should be used when selecting cable. That is, multiply the cable tension previously calculated by three to determine what strength and therefore size cable to use.

B. Winch

Winch selection, as with cable, should be based on cable tension times a safety factor of three. Sears Roebuck and Co. has a good selection of winches ranging from 1000 pound capacity with a 3:1 gear ratio (maximum mechanical advantage of 38:1) to 2500 pound capacity with a 12:1 gear ratio (maximum mechanical advantage of 21:1). Even if you don't need the higher lifting capacity the selection to the higher capacity model with the mechanical advantage and higher gear ratio will save wear and tear on your arm muscles.

C. Pulleys

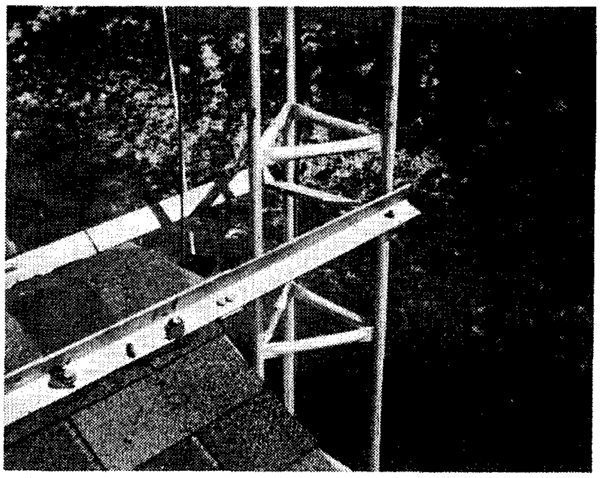
The pulley should also be selected based on required lifting tension times safety factor. The other pulley considerations are diameter and groove size. To realize maximum cable life the diameter of the pulley should be: for 6 x 7 cable D=72d (d= diameter of cable), for 8 x 19 cable D=31d. Note that the more flexible cables require smaller diameter pulleys. Because, at most, the cable in this application will see highly intermittent use it would be appropriate to use pulleys as much as one half that diameter specified.

Since the Sears winches have small diameter drums, several layers of cable should be turned on the drum before the weight carrying cable is wound on.

It is recommended that the pulley groove diameter be the same size or 1/64 larger than the nominal cable diameter. Too small a groove for the cable it is to carry will prevent proper seating of the cable in the bottom of the groove and consequently uneven distribution of load on the cable will result. Too large a groove will not give the cable sufficient support.

Operation

One important consideration in lowering a tower of any size is the lateral leverage (or twist) the tower exerts on the vertical base and hinges. This leverage reaches maximum when the tower is completely horizontal but not resting on the ground. In that position any wind from the side, especially with a large antenna mounted at the tower apex, will tend to swing the tower sideways twisting the base. After one sad experience in which the author's tower was



Intermediate pulley mount and house bracket.

swung 45 degrees by a gust of wind; restraining lines were used on all lowering and raising operations.

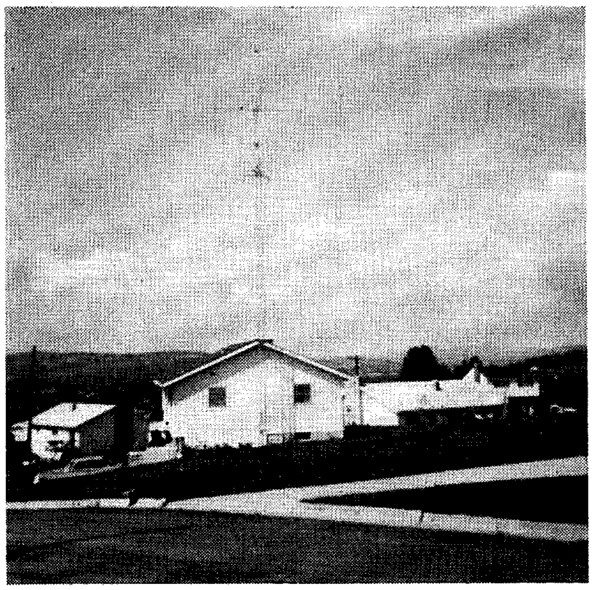
The restraining line operation consists of running one end of a 1/4 inch line through a guy thimble, used to hold one set of guy lines, then on to a point about 20 foot up the tower where it is made fast. The other end of the line is run through the other guy thimble and likewise tied to the 20 foot point on the tower. The center of the line then is brought back to the base of the tower where the slack can be taken up by the operator. The line is either taken in or let out depending on whether the tower is being taken up or down. (My tower has one set of guys at the top, one anchored to the roof of the house and the other two to the earth anchors).

This use of restraining lines requires very little effort to keep the tower from swinging about the base even in quite strong wind gusts. The best solution, of course, is to wait for a calm day. However, even in that case, it is best to have some insurance in the form of the restraining lines.

Reducing winch load

One method to reduce the load on the winch and save muscle power is:

1. Mount the intermediate pulley as before.
2. Mount a second intermediate pulley at the tower lift point.
3. Fasten one end of the lifting cable to the angle iron holding the first intermediate pulley. Run the cable through the 2nd intermediate pulley on the tower then back through the first intermediate pulley then down to the winch. This arrangement can cut the lifting



The erect tower—A neat installation

load on the winch by as much as 5 percent.

Operating procedure

1. Connect restraining line.
2. Remove guy lines (if used) from side of tower opposite hinge.
3. Remove house bracket holding screws.
4. Remove rear leg (base) holding screws.
5. MAKE SURE NO ONE IS STANDING IN FALL PATH OF TOWER!
6. Lower tower taking up slack in restraining line. The restraining line job is an easy job for the XYL or neighbor.

Finally—frequently inspect the tower construction, winch, cable, hinges, pulleys and other hardware for signs of strain and wear!

. . . W2AJW

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Panel Gap Filler

Although rack panel and rack cabinet dimensions are supposedly standardized, so that all parts are completely interchangable, almost all large rack-and-panel assemblies are afflicted with an interpanel gap, usually at a most unsightly location, and amounting to from 1/16" to 1/4". Location of this gap can be shifted somewhat by adjusting panel positions, but usually the gap cannot be entirely eliminated.

No standard fitting to fill these gaps has been marketed by the makers of rack-and-panel equipment. In fact, one manufacturer, in answer to a query, stated "all of our racks and panels fit perfectly, and no spacers are necessary". Perhaps he goofed on the "paint allowance".

Search for a suitable panel gap filler, to eliminate the need for milling out a special channel section, disclosed that an aluminum extrusion, used in connection with phenolic table tops and counter covers, is ideally suited to the purpose. This, known as a "divider", has an asymmetrical "H" cross section, as in **Fig. 1**, with the short bar of the "H" highly polished. As it is made of half-hard Dural, it is easy to cut and fit into place. Front surface can be left bright, or painted in any desired color to match, or contrast with, the panels. Dividers are made to accommodate 3/32, 1/8, 3/16 and 1/4 inch panels, and cost about 30 cents per running foot retail in small quantities. Stainless steel dividers, in similar, dimensions, are also available, at considerably higher prices. . . . IVES

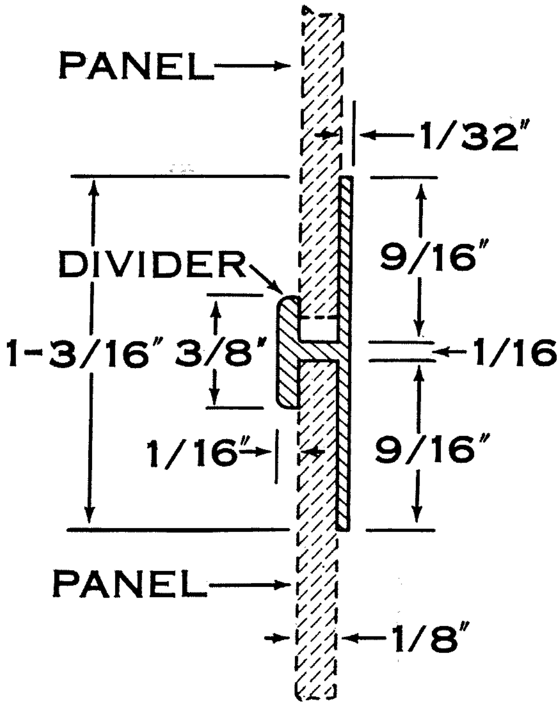


Fig. 1. Cross-section of aluminum divider, showing use in filling panel gap.

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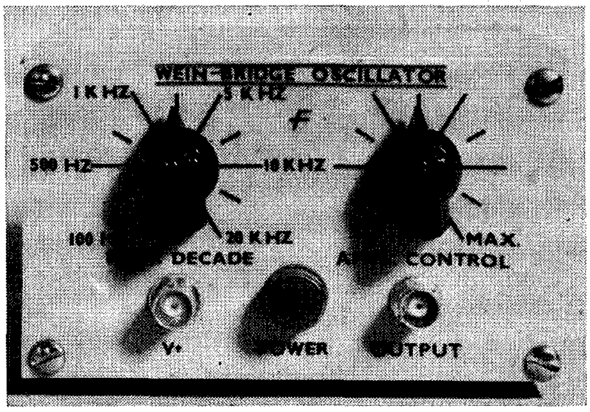
Project Leader Communications
Fairchild Semiconductor
313 Fairchild Drive
Mountain View, Calif. 94041

An Integrated-Circuit Audio Oscillator and Amplifier



A fixed-gain amplifier (such as the μA716C) may be easily connected as a Wien-Bridge oscillator capable of delivering up to 100 mW of power at frequencies from 100 Hz to 20 kHz. The low cost of the device makes it particularly attractive for the cost-conscious amateur or audio-phile. An oscillator of this type can be used for checking out a transmitter, high-fidelity sound system or as a code-practice oscillator.

The μA716C is basically a high-gain feedback amplifier constructed on a single 50-mil square chip and mounted in an eight-pin, TO-5 metal can. The device has four gain options of 10, 20, 100 and 200 available, but only the gain of 10 connection is needed for the oscillator. Operation as a Wein-Bridge oscillator is accomplished by adding suitable resistors and capacitors in a positive feedback loop, and by the addition of a diode and transistor automatic gain control. Although fixed frequencies of 100 Hz, 500 Hz, 1 kHz, 10 kHz, 15 kHz and 20 kHz are shown in the schematic, any frequency within this range may be obtained by suitable changes in the feedback capacitors. The frequency of oscillation will be given by:

$$f_{osc} = \frac{1}{2\ RC}$$

$$= 33/C_{\mu}F \qquad \text{for } R = Sk$$

Where R and C are the resistor and capacitor connected to switch $S1_B$.

The complete schematic of the oscillator is shown in **Fig. 1**. The layout of the oscillator

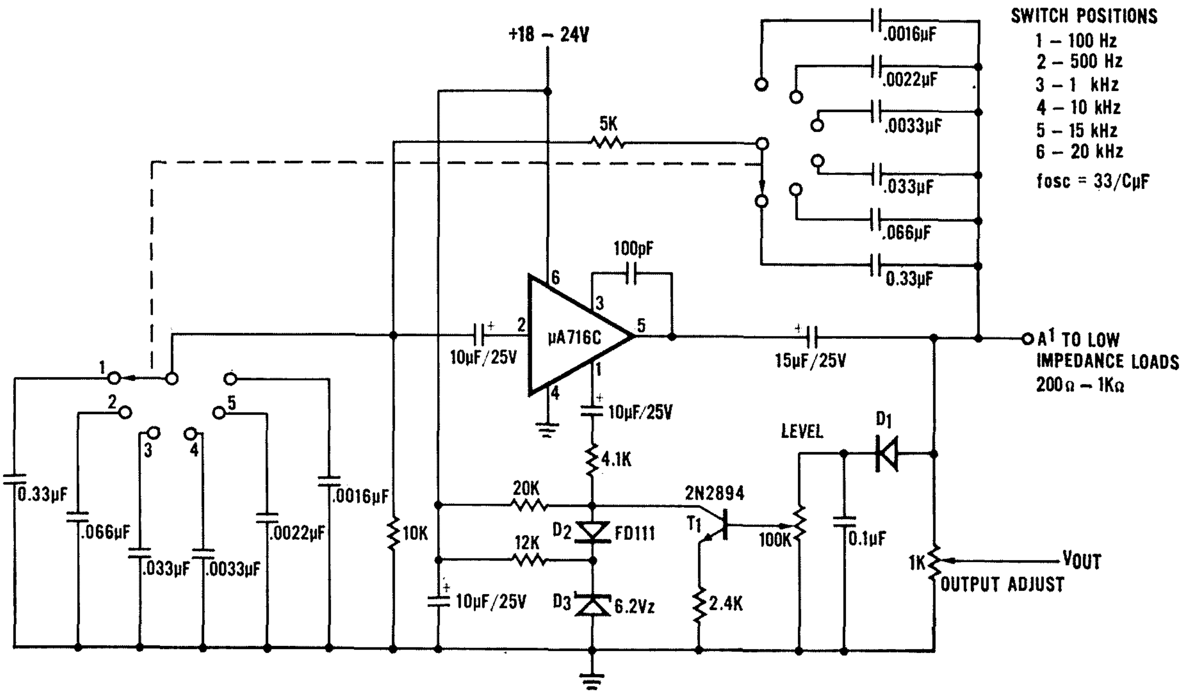


Fig. 1. The complete schematic of the oscillator.

is not critical, but should follow a neat pattern to assure error-free wiring. Selection of an operating frequency is accomplished by the two-pole six-position switch, S_1. Detection of the output voltage is provided by diode D_1, which rectifies the output voltage and applies the filtered dc to transistor T_1. Transistor T_1 sinks current from the 20K resistor connected to diode D_2, setting the gain of the μA716C at the point just sufficient to allow a low-distortion sine-wave oscillation to take place. Diode D_3, a 6.2 volt zener biases transistor T_1 sufficiently out of saturation to keep it from affecting the AGC performance. By changing the current through diode D_2, its dynamic resistance is altered in the direction necessary to establish a stable oscillation of the μU716C.

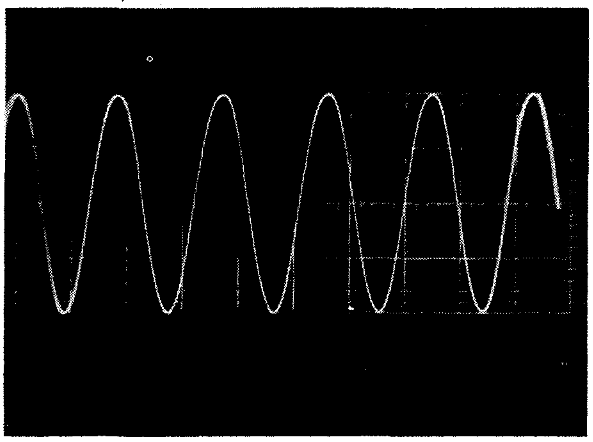


Fig. 2. A photograph of the output of the μA716C.

A photograph of the output of the μA716C is shown in **Fig. 2** for an output of 4 V_{pp} at 1 kHz. The level control connected to T_1 should be adjusted for the maximum output

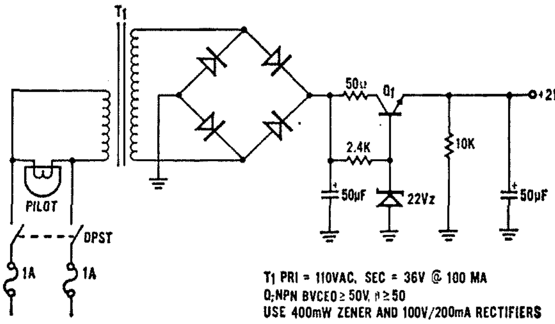


Fig. 3. Power supply

necessary at point A'. Output to the external circuitry should be adjusted to the desired level by the IK ohm potentiometer. Operation with an output at point A' of 8 volts peak-to-peak, or less, will result in minimum distortion (less than 1 per cent) while a higher output will be somewhat more distorted (less than 3 per cent at 15 V_{pp} output).

The output from the 1K-ohm potentiometer should be sufficient for most applications, but if lower load resistances are to be used (less than IK but greater than 200Ω) the output may be taken directly from point A'. Since the device operates from a low-voltage supply, keying may be accomplished in series with the headset if the oscillator is used for code-practice.

If a power supply between 18 and 24 volts at 50 mA is not available, the circuit of **Fig. 3** may be used for power. If desired, this supply could be built into the same box as the oscillator, to make the unit self-contained.

The uA716C integrated amplifier may

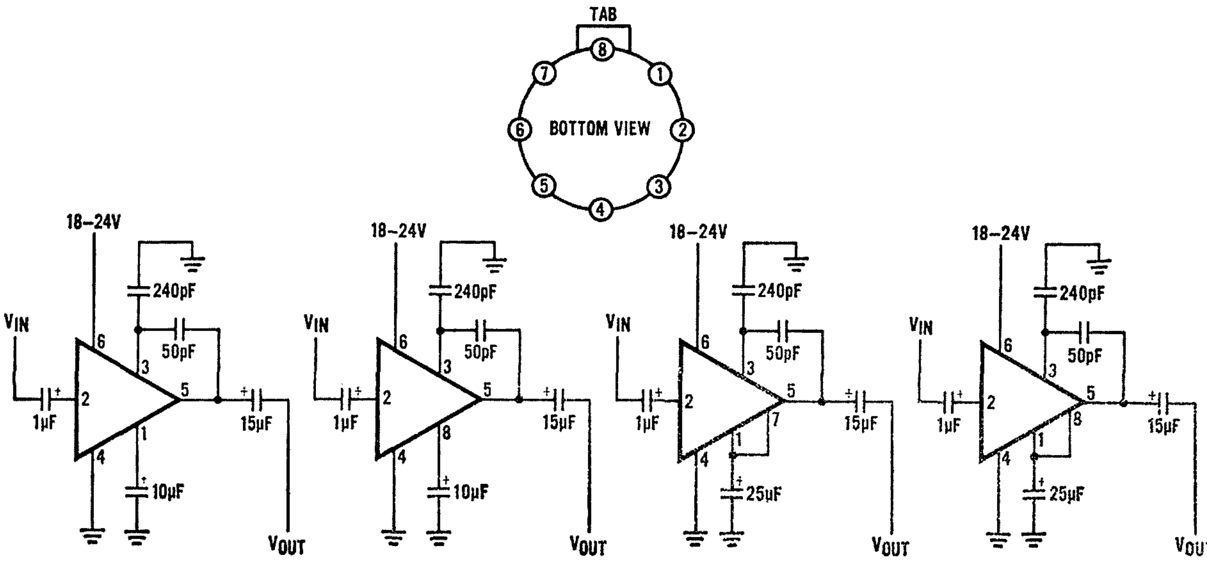
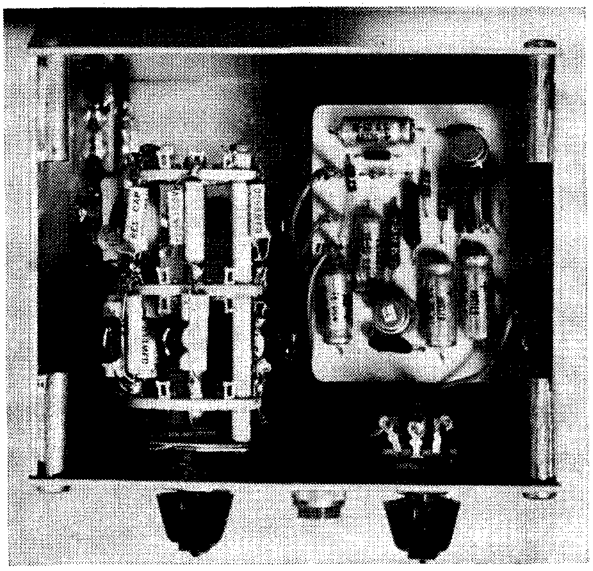


Fig. 4. Diagram showing connections for the μA716C.



Suggested layout.

also be used for driving headsets in either a communications receiver or for a high-fidelity sound system. Because of the large amount of feedback used in the amplifier the distortion of signals is very low (less than 1 per cent) so long as the input to the amplifier does not exceed the saturation value. The connection of the amplifier for each of its available gain options is shown in **Fig. 4.** To ensure low distortion the maximum peak-to-peak input voltage to the amplifier must not exceed

$$\frac{0.8 \times \text{V Supply}}{\text{Voltage Gain}}$$

For example, if a 20-volt supply is used and the voltage gain is 10, the maximum input voltage would be 1.6 volts peak-to-peak. For a voltage gain of 20, the maximum input would be 0.8 volts, etc.

Caution must be exercised when using this device to avoid shorting the output of the device when the supplies are turned on and to limit the minimum load impedance to 200 ohms. Possible damage to the amplifier may result if these suggestions are not followed.

. . . W7AKS

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

The New Tower

Muriel Joan Smith WA2GXT
135 Highland Ave.
Highland, New Jersey 07733

I'm a ham by marriage . . . and by love. By marriage, since I never would have given any thought to the hobby if my OM wasn't so vitally interested in it (it's easier to join 'em than fight 'em). By love, because it's impossible to shrug off such a fascinating pastime after that first contact.

Now, after this summer, I can also say I'm a ham by courage . . . I've had my first legal battle and climbed my first forty foot tower!

When we put our first antenna up, it was against the side of a house, easily accessible because of a lower roof. Then we moved, and the second antenna went up on the chimney, flanking a rather steep roof. I didn't assist with the installation of this one, claiming insufficient time and energy, the direct result of the acquisition of a twelve room, three-quarter century old house.

Then, after months of hard saving and careful scanning of ads, we agreed on a forty foot, self-supporting Spalding, which, we further agreed, would be erected in the back yard.

Because it is no small trick to hide a tower which is taller than anything else in the neighborhood, and because we wanted to avert the possible order to take it down because of neighborhood complaints, we decided to go about it legally and get a building permit . . . our very first mistake!

I went to the municipal building to read the section of the building code which governs towers. The regulations gave the necessary thicknesses of steel for the tower, and the approved widths for withstanding wind velocities. It said nothing about distance from other buildings, limit on height, or related subjects. This might turn out to be easy after, all . . . we even jived with the building code!

We knew Spalding had been in business long enough to have figured out wind velocities, snow weight and other minor problems, so we didn't give that part any thought as we headed to the building inspector for the required permit. (At this time, I'd like to interject that the BI is a non-ham, and a pigeon fancier to boot.)

The BI said fine when we told our plans, he'd be up to issue the permit. But a few hours later, he called and jubilantly (well, we thought he was, anyhow) claimed we couldn't put up a tower . . . the ordinance reads, he said, an antenna structure can't be any higher than half the width of our property. Well, to somebody who had just paid the better part of a hundred dollars to one of the best ham dealers around, and who owned a piece of property fifty-six feet wide, slightly narrower than the supposed eighty foot requirement for a forty foot tower, this didn't sit too well. Rather than admit defeat, we naturally assumed the BI read the ordinance wrong. Or even, the ordinance might have to be amended. It was as simple as that.

Working under the first assumption, we again visited the borough offices to read the building code (whose pages number in the thousands) with the inspector. Right off, (thank goodness) we found he had read the ordinance wrong. Our next problem was to convince him of it.

The inspector had completely disregarded the section on towers (he said that only referred to the "big city" where the big radio stations are) and read the section governing antennae. This section did clearly state that the antenna structure could not be of a height more than half the width of the property. We even agreed with this, indicating that our antenna structure, to be mounted atop a forty foot tower, was about four foot high.

We explained the difference between an antenna and a tower . . . but it was all to no avail. The BI was convinced that since the antenna and the supporting pole were to be mounted on top of the tower, this indeed made the tower an "antenna structure."

Our next course of battle was to ask if every house in the borough was to be considered an antenna structure, since every house (well, almost) had a television antenna atop it. We further pointed out that none of the houses, barring any, were less than half the width of the propery on which they were built.

Of course, our friend the BI disagreed. The primary purpose of the house, he said, was to live in; an antenna on top was a secondary purpose. Here we pointed up two more facts; one, the ordinance said nothing about primary or secondary purposes, and two, even if it did, perhaps we were erecting the tower because we like the looks of one hundred and twenty pounds of steel neatly arranged in the backyard. That a four element six meter antenna would be atop it was secondary. We went a few more rounds, but an inspector who uses pigeons rather than electronics for communications is a hard one to convince of the merits of amateur radio and related topics. He denied us our permit.

This left two other avenues open to us. We could either do it legally or illegally. For the first, we could get his denial in writing and appeal to the zoning board for a variance. But this would be like admitting the inspector was right, a fact of which we still weren't convinced. We could hire an attorney and have him explain the differences between an antenna and a tower. But after spending our hard earned and harder saved funds on said tower, this wasn't too feasible an idea either. We could plead our cause to the several hundred other hams in the county and picket borough hall . . . but pickets are too common now. We could appeal to the governing body and get their decision on the matter. But this would take months, and at a time when 6 meters was wide open, this wasn't too brilliant either.

The only other way open was the illegal way . . . . . go ahead and put up the tower and let the permits fall where they may.

The best part of the next day was spent digging a four foot deep hole, two feet in diameter, to house the base of the structure. Now, this sounds easy enough for a few well-bodied hams to tend to, but in a yard that has a slope of about forty degrees and earth which seems to be made entirely of ironstone in giant chunks, it's easier said than done.

But finally, the hole was dug, the base inserted, and the easy part began. It took a scant few minutes to assemble the five sections and walk them up to their full forty foot height. Next came mounting the antenna, antenna structure, and the rotor, and we were in business.

The OM climbed the tower many times, just for a lark, to get the feel of it, and to see the view (we're not far from the ocean). On my first attempt I climbed twenty-four feet and began to think how stupid it was to do this for no reason. I also figured it would be unfair to the OM if I climbed to the top. After all, I might fall and break a leg or something, and he'd have to take care of the four harmonics . . . . . how could I be so thoughtless?

But the days went by and that tower stood in the yard, the topic of conversation at all neighborhood coffee clatches, and the envy of every kid in town. But to me, it was a hundred and twenty pound hunk of steel that had the best of me. It seemed to stare down haughtily at me from its great height, and dare me to do something about it. I couldn't take it any more . . . I had to climb it or admit defeat . . . . . which was the worse alternative?

So with good sturdy shoes and a large helping of determination, I made the ascent. And do you know, it's not bad at all.

The tower stands now as a part of the community. It's ignored by the BI, held in awe by the neighbors, respected by the kids . . . . . and best of all, conquered by me, an xyl who's ready to climb it any time!

. . . WA2GXT

New 160 Meter Allocations

We have been advised by the FCC that effective July 1, 1968 there will be new frequency and power allocations in the 160 meter band. In order to facilitate printing of this information, we have established the following key which will guide you in finding your frequency and power allocations for your particular state.

a. 1800-1825 kHz
b. 1825-1850 kHz
c. 1850-1875 kHz
d. 1875-1900 kHz
e. 1900-1925 kHz
f. 1925-1950 kHz
g. 1950-1975 kHz
h. 1975-2000 kHz
0 Not usable
1 100 watts days, 25 watts nights
2 200 watts days, 50 watts nights
5 500 watts days, 100 watts nights
k 1000 watts days, 200 watts nights

	160M Segments							
	a	b	c	d	e	f	g	h
AL	5	1	0	0	0	0	1	5
AK	2	0	0	2	0	0	0	0
AZ	0	0	0	0	0	2	5	k
AR	k	2	1	0	0	1	1	5
CA	0	0	0	0	1	2	2	5
CT	5	1	0	0	0	0	0	0
CO	2	0	0	0	0	2	2	k
DE	5	1	0	0	0	0	0	1
DC	5	1	0	0	0	0	0	1
FL	5	1	0	0	0	0	1	5
GA	5	1	0	0	0	0	0	2
HA	0	0	0	0	2	1	1	5
ID	1	0	0	1	1	1	1	5
IL	k	2	1	0	0	0	0	2
IN	k	5	1	0	0	0	0	2
IA	k	2	2	0	0	1	1	5
KS	5	1	1	0	0	1	2	k
KY	k	5	1	0	0	0	0	2
LA	5	1	0	0	0	0	1	5
ME	5	1	0	0	0	0	0	0
MD	5	1	0	0	0	0	0	1
MA	5	1	0	0	0	0	0	0
MI	k	5	1	0	0	0	0	1
MN	5	1	1	1	1	1	1	5
MS	5	1	0	0	0	0	1	5
MO	k	2	1	0	0	1	1	5
MT	1	0	0	1	1	1	1	5
NB	5	1	1	0	0	2	2	k
NV	0	0	0	0	1	2	2	k
NH	5	1	0	0	0	0	0	0
NJ	5	1	0	0	0	0	0	0

	160M Segments							
	a	b	c	d	e	f	g	h
NM	1	0	0	0	0	1	5	k
NY	5	1	0	0	0	0	0	0
NC	5	1	0	0	0	0	0	1
ND	5	1	1	1	1	2	2	k
OH	k	5	1	0	0	0	0	1
OK	5	1	1	0	0	1	2	k
OR	0	0	0	0	2	1	1	5
PA	5	1	0	0	0	0	0	0
RI	5	1	0	0	0	0	0	0
SC	5	1	0	0	0	0	0	2
SD	5	1	1	1	1	2	2	k
TN	k	5	1	0	0	0	0	2
TX	2	0	0	0	0	0	1	5
UT	1	0	0	1	1	2	2	k
VT	5	1	0	0	0	0	0	0
VA	5	1	0	0	0	0	0	1
WA	0	0	0	0	2	0	0	5
WV	k	5	1	0	0	0	0	1
WI	k	2	2	0	0	0	0	2
WY	2	0	0	1	1	2	2	k
KP4	5	1	0	0	0	0	0	2
KV4	5	1	0	0	0	0	0	2
KS4	5	1	0	0	0	0	1	5
KC4	5	1	0	0	0	0	0	2
KB6	1	0	0	1	1	0	0	1
KG6	0	0	0	0	1	0	0	1
KJ6	0	0	0	0	1	0	0	1
KM6	0	0	0	0	1	0	0	1
KS6	2	0	0	2	2	0	0	2
KW6	1	0	0	1	0	0	0	0
KP6	0	0	0	0	2	0	0	2

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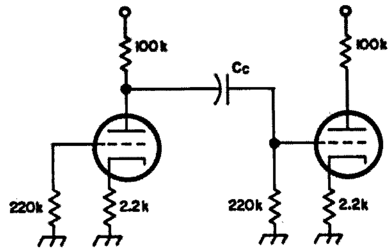

Fig. 1. Two stages of audio, resistance coupled.

Some Audio Thoughts

Sooner or later the average ham rolls some sort of an audio modulator and faces the task of shaping the frequency response. Some fortunate souls drag out the slip stick or log tables and design a circuit which works like a dream. You and I hunt the junk box and solder in parts, hoping that Providence is guiding our hands as well as the audio bandpass. What I would like to suggest is that there is some sort of happy (?) middle ground.

Lets examine **Fig. 1**. It shows two stages of audio, resistance coupled. The triodes have a mu of about 70 and the assigned values of plate grid and cathode resistors are in the ball park. The cathode bypasses have been intentionally omitted to make the following point. If we put a 1 kHz tone through the amplifier and bypass either cathode with a high value capacitor (10 µF or so) we will notice that the gain of the stage goes up by six to eight db. The response at this point would be flat from about 50 Hz to well past the upper limit that we would be interested in obtaining in a communications modulator. Naturally if we bypassed both cathodes the overall gain would be some 12 to 16 dB higher than without the bypasses.

The frequency bandpass of average interest to the ham as regards his audio modulator runs from about 300 Hz on the low end to about 3000 Hz on the high end, a band pass which will provide adequate voice identity and intellegibility without taking up too much spectrum with side band or bands.

Lets take a peek at **Fig. 2**.

This shows what happens when the cathode resistors are bypassed by various small values of capacity. Notice that the 0.3 µF condenser provides all the bypassing needed at the high end to retain stage gain and at the same time gives a moderate roll off at the low end. This points up the idea that the voltage gain stages of your modulator do not need the big fat electrolytics so commonly seen. The smaller properly selected values do the trick nicely.

	100 Hz	300 Hz	1 kHz	3 kHz	5 kHz
0.1 mfd	±0	+1	+3.5	+7	+7.5
0.2 mfd	±0	+2	+6	+7.5	+8
0.3 mfd	+1/4	+3.5	+7	+8	+8
0.4 mfd	+1	+4.5	+7.5	+8	+8
0.5 mfd	+1	+5.5	+7.5	+8	+8

Fig. 2. Gain vs. Frequency for various values of cathode by-pass.

The remaining reactive element in our simple voltage amplifier in **Fig. 1** is the interstage coupling condenser Cc.

The second stage grid resister is specified as 220 K, so the value of this coupling condenser is examined with this value in mind.

The coupling condenser in conjunction with the grid resistor forms a frequency sensitive voltage divider between the two stages. Since capacitive reactance varies inversely with frequency, the higher frequencies are more readily passed than low frequencies.

Let us take note of some Xc values at 1 kHz.

0.01 μF has a reactance of about 16,000 ohms.
0.005 Xc is about 32,000 ohms
0.001 Xc is about 160,000 ohms

Notice that only the latter value starts to exhibit a large proportion of the grid resistor 220,000 ohms.

Taking the circuit of **Fig. 1** without any bypass condensers across the cathode resistors, we substitute the three values of coupling condensers specified and the resulting frequency responses are tabulated in **Fig. 3**.

	100 Hz	300 Hz	1 kHz	3 kHz	5 kHz
.01	-1.5	-0.5	±0	±0	±0
.005	-3	-0.5	±0	±0	±0
.001	-8	-2	±0	±0	±0

Fig. 3. No cathode by-passes.

Now let's put the two methods of response control together by putting a 0.3 μF condenser across one of the cathodes bias resistors and substituting the same three values of Cc in the amplifier. **Fig. 4** shows the results of the combination.

Notice that the 0.001 μF Cc really begins to tailor the low end, although the .005 μF Cc would probably sound just as acceptable keeping in mind that the combination of different microphones and different voices coupled with shack acoustics enter into the final decision as to what is right for you.

You might well wonder what the relative responses would be if you repeated the experiment with a cathode bypass of 0.2 μF. The results here would be close to the values in **Fig. 4.** However if you dropped the cathode bypass value down to 0.1 μF you would notice that the 1 kHz gain would drop about three dB over the condition we had when we bypassed the cathode with a juicy electrolytic. This loss in gain would show up as a high frequency tilt in the response curve. Since we have achieved a reasonable depression of the low end of the response curve with little finite gain loss this would be designing in the wrong direction. So far our values of cathode bypass and coupling condenser most favorably disposed to meet our ends have been 0.3 μF and 0.001 respectively.

Recalling so far that we have only bypassed one of the two cathodes let us examine what happens when we bypass *both* cathodes with 0.3 μF condensers. We now

	100 Hz	300 Hz	1 kHz	3 kHz	5 kHz
.01	-7.5	-4.5	±0	±0	+0.5
.005	-9.5	-4.5	±0	±0	+0.5
.001	-21	-8	±0	±0	+0.5

Fig. 4. 0.3 mfd by-pass.

pick up some six to eight db of gain and should expect the curve to tilt up in both directions. The results tabulated in **Fig. 5** show the results. These results are interesting but must be examined with respect to the rest of the contemplated circuit. An unbypassed cathode is a very nice point to return feedback which will contour the upper frequency response of your amplifier, so you may not want to bypass at this point. It is relatively simple to "build out" a modulation transformer with shunt capacitors to control the high frequency end of your modulator but a readily available feedback point is nice from the standpoint of distortion reduction also.

	100 Hz	300 Hz	1 kHz	3 kHz	5 kHz
.01	-12	-7	0	+2	+2
.005	-15	-7	0	+2	+2
.001	-26	-10	0	+2.5	+2.5

Fig. 5. Both cathodes by-passed.

If you favor a pentode triode combination for mike amplification the same general principles hold as already outlined. Playing with pentodes generally allows you to trade off surplus gain for the frequency roll offs desired. In addition you have the screen grid to play with as a low end control. Instead of bypassing the screen with a heavy hand, try selectively bypassing it with different values of capacitor and you will readily demonstrate that between complete by passing and the unstable too lightly bypassed region that there is an interesting area of frequency control available to you.

. . . W3KBM

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db

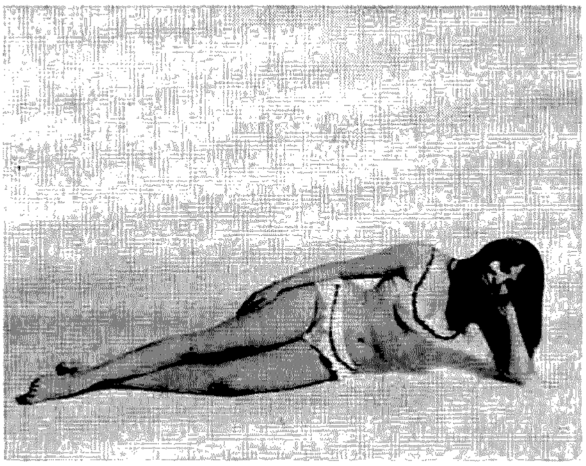


Fig. 1. Since db are hard to illustrate, the author suggested we use a pretty girl. Appropriate since db is a measure of power and never underestimate the power of a woman. Our model is the lovely Mrs. Wayne Green (Lin), wife of our publisher.

Sooner or later it had to happen. The F.C.C. is putting db questions in its license examinations. The student who told me was quite bitter about it. He had memorized both db formulas and they did not help him a bit. It seems the Commission furnished neither slide-rule or log tables; they expected him to work the example in his head!

Questioning revealed that the example concerned the net gain in db of an amplifier with such and such tube gains, these and those transformer ratios, which were easy enough if you knew the corresponding db ratios, which he did not. Yesterday, a very few knew them; today, many find them useful, and tomorrow they will be required of all technicians. Since learning them is little more than a knack so there is little reason for procrastination.

In the early twenties, the AT&T Co. had a unit which they called a "Standard Cable Mile." This was the loss of one mile of exchange cable. They didn't coil up a mile of it in the basement for comparison, of course. They had a panel with a variable attenuator having one *mile* steps, and a switch. A tone through the panel was switched either to the circuit to be measured, or to a comparison circuit, and the result judged by ear.

Science marched on, and they came up with the Transmission Unit, or TU. This logarithmic unit was approximately the same as the Cable Mile, but by this time they had transmission measuring sets calibrated in TU. These were much more accurate and convenient.

Later still, the TU was renamed the decibel, or one-tenth Bel, one L. The Bel was named for A. G. Bell, of whom you may have head. The db was always to be written in lower case, and singular! Originally it was recommended that db be handwritten with the d and the b run together, sharing a common stem. Indeed, it can be easily and rapidly written this way, with a twitch of the fingers. This convention has been abandoned, probably because of its vulgar appearance[2]. This is one more reason for the paucity of illustrations in this article[3].

Now we need a few rules of thumb—and ear—to locate ourselves in this unfamiliar countryside. They should be memorized and used whenever possible for familiarization. You will find them useful.

One db is really quite small, with a power ratio of only 1.259 to 1. Don't memorize this, but remember that a *one db change in power is the smallest that can possibly be heard.* This is true whether you are talking about −37 to −38 db or plus 52 to plus 53 db—*the ratio is the same.* Broadcast stations have gain controls with steps. You never hear the steps, because they are ½ db ones.

3 db is a power ratio of 1.995 to 1. Remember it as *2 to 1 power ratio,* which is close enough[4]. With careful listening, you can detect this change in power in program material, speech, etc. You might say it is the *smallest change in power that can be detected* under average conditions.

6 db is a power ratio of 3.931 to 1. Remember it as 4 *to* 1*;* the error will never be important. 6 db *is the smallest worth-while increase in power, so far as the ear is concerned.* Significantly, it is also equal to one

"S" unit. 6 db is noticeable, but not overpowering.

10 db is a power ratio of 10 to 1 and it is EGG-ZACTLY ten to one by definition. Such a power increase *cannot be overlooked* under any circumstances—it is well worthwhile. When a broadcast station increases power, it often does so by ten db steps—5 watts to 50, 50 to 500 to 5,000.

If you swap your 10 watt hi-fi amplifier in on a 20 watt one, it will not sound "twice as loud." In fact, you will hear little if any difference, except possibly a little less distortion. Every ham knows about increasing power to get out better. If 100 watts puts you about 3 db above the average noise, you will be hard to read. 200 watts will then put you 6 db above the noise which is more better, and you will settle for that if you can't get plus ten db, the full gallon.

Most telephone lines will average out *6 to 10 db in loss.* You can talk quite easily over a line with 20 db loss—this is 10 plus 10 db or −20 db (minus to indicate loss) *or* 0.1 power *times* 0.1 power, which is 0.01, the ratio of input to output power.

If your line measures suddenly 35 db, you can suspect that *one side of the line has has gone,* especially if it also goes noisy. But you can usually still talk on it.

10 db is the most loss you can talk over—and this requires *no distortion* and a *quiet line.* You can hear the guy on the other end clearly, but oh so faintly—so far away!

And right here, my friends, is the Secret of the Barefoot SSB exciter. For many years, the transmission advantage of SSB over AM (with transmitted carrier) was explained on a concentration of sideband power at the transmitter (6 db) and halved receiver bandwidth (3 db) basis. The total advantage claimed is 9 db. Now this can be proved by mathematics, but is ridiculously conservative, as any ham knows. The real reason SSB gets out is that it is a *low distortion system.* I realize that many will scoff at this, but it is nevertheless a fact. It is the only way to account for the known facts—and the next time you hear someone's five watt exciter clear across the continent, think of this. He's faint—very faint!—but you can hear everything he says. An AM signal would be as loud—probably louder—but you couldn't get intelligence out of it.

To get back to the power ratios: they are all positive ones. To get negative ones, you just turn the fractions over, or divide them into one. Of course, if you know your Logarithms, you can work with negative values all right, and sometimes you have to—remember 8 dot umpty-ump −10 to simplify a minus two characteristic? But with db, nobody, but nobody!—ever does this. They figure positive values, and remember to call the answer negative. Plus three db (up) is twice power, while minus 3 db is ½ power. But it is easier to think two to one rather than one-half, and the *number comes out the same in db,* you just have to remember to call a loss, *minus.*

db notation is full of pleasant little surprises like this, if you know how to find them. Now rest your eyes a moment on **Fig.** 1, after which we'll make the following small table:

Table I

db	Power ratio
10	10 to 1
20	100 to 1
30	1,000 to 1
40	10,000 to 1

You see? A decimal, or finger-counting system—and you thought it was hard! Notice that the db values *add,* by tens, and the power ratio values *multiply* by factors of 10. It sounds a little silly to convert power ratios to db just to save the trouble of multiplying ratios, but in practice it is very much easier.

Here's something else to notice: 1 db (one-zero) equals 10 to 1 and ten has one zero in it. 20 db (*two*-zero) equals 100 to 1, and 100 has *two zeroes*[5].

At this rate, 60 db represents a power ratio of one million—a one, followed by six zeroes. How very nice it is to have something simple for once!

How about the values between the tens? Are we not approximating a little too much? Well, we haven't finished yet, for one thing, and the "ten-spots" are the ribs of the structure which we must get firmly in mind.

Everyone who proposes to explain db notation gets asked to cut out all the palaver and just draw a graph. OK, take another glance at **Fig.** I and get a piece of 8½ x 11 and we'll draw one.

What scale shall we use? How about 0 to 100 db by tens along the bottom edge, and 1/10 inch to the db or vice-versa along the left edge? Start off with zero-zero in

the lower left side-pocket. At the 10 db point, go up 1/10 inch and make the second dot. 20 db is ten times as much as 10 on a linear scale, so put it 1.1 inches over the base line at 20 db. 30 db, 11.1 inches, 40 db, off the paper, hmm!—50 db, out of the house, 60 db, across the street, 70 db across the river and under the trees, 80 db, the next town, 90 db, Peoria, and 100 db, Hawaii.

Obviously our db scale was too large. So let's make 1 db equal to one-hundredth inch. This keeps us on the paper ten db longer, but we still wind up in Peoria at 100 db. Me, whenever anyone says "One Hundred db." I stand and uncover. It is not a number to be taken lightly. OK, students—just how big *is* 100 db? What is the power ratio? If you made your scale 1/1000 of an inch to the db, where would you go off the paper? Of course I have heard of log paper. It tricks the eye, but never completely. You know the log scale represents a large quantity, but just *how* large? I can visualize it better myself as distances such as Peoria.

When Logarithm sharks and slide-rule jockeys work with db, they invoke "powers of ten" and "adding and subtracting exponents" and similar necromancy. A slide-rule is very useful for smelling out the intervals between the powers of ten, but stupid as hell about decimals, as any devotee will tell you. So your engineer has memorized his powers of ten until it is permanently in the head-bone, which-is-connected-to-the-neck-bone, and the big act with the slide and the cursor is just to find out how much 3.4 of 43.4 db is—he already knows how much the 40 db is.

So you cannot snow the engineer—snowing is his business. (I'm kidding—it is only a *very small part* of his business.) But operating and supervisory personnel are fair game, and easy game usually—they do a lot of kidding themselves and so are vulnerable.

Like so: Someone, possibly under post-hypnotic suggestion, happens to mention that Tropo-Scatter systems sure have a high path-loss——150 *db* or so. Don't *never* pipe up with "That's one times ten to the minus fifteenth." They'll shrug it off. Instead, fish out a piece of paper and *slowly* write a 1 with fifteen zeros after it. Do not *say* fifteen, or they may get the connection. Unless they

know their logs well, they *still* won't get it after working it out with the tables—I don't know why, but they don't. Abstracted, maybe.

Maybe some wise-guy reads 73. Smile and shrug and walk away. Did he do his home-work? If not, you will still win out; soon no one will argue db with you if you know your stuff. This is the difference between *knowing* a subject, and knowing *about* it.

In that connection, people who know the db formulas, and little else about the db notation, often say "dee-beez of voltage" and "dee-beez of power." as if these were different things.

Not so. The db is by definition, a power ratio—and electrical power at that. The other formula? Well, when you say "Power" or "Watts", generally two formulas come to mind: E x I and I^2R. So do you say "I X E power" and "I^2R power"? Hardly. Watts is watts. And db is db, and this turns out to be simpler, not more complex. You could actually take the formula for power ratios, db equals 10 log P2/P1 and substitute E2/E1 or 12/I1, *provided* you squared the E or I term first. It actually works! But it is a lot of trouble, and one of the very nicest things about Logarithms is that the *square* of a number is equivalent to its log *doubled*. So put a two in there somewhere and you can use the E or I ratio directly. The two times the 10 is 20, hence "20 log—" in the formula. *A db is always a db,* and there is only one kind. Since power is proportional to E or I *squared* you cannot compare 2 to 1 power (3 db) with 2 to 1 voltage (6db) legitimately.

Another glance at **Fig. 1**, another table:

Table II

db	power ratio	E or I ratio
30	1,000	31.62^{5}
3	2	1.41^{7}
6	4	2
10	10	3.162
20	100	10
30	1,000	31.62^{5}

You can complete the table yourself, taking it as high as you wish.

Now come we to *levels* expressed in db-. A db is a *power ratio* which expresses a

gain or loss very well. Suppose we take some reasonable amount of power, such as the milliwatt, and call this 0 *dbm*—the *m* for *milliwatt*. Counting up ten db to *plus* 10 *dbm* we have 10 milliwatts, while down to —10 dbm we have one tenth milliwatt, or one-ten-thousandth of a watt. Simple enough.

One milliwatt peak, or 0 *dbm peak* is the power you can expect out of a telephone set, or an F-1 button. At one time, 6 milliwatts was a common reference but with the growth of Broadcasting, the milliwatt reference was universally adopted for uniformity. Note well that no impedance is specified. You can have a dbm at 1200 ohms or 600 ohms or 75 ohms or 124 ohms —all different voltages, all the some power.

In that connection—the dbv or db referred to one volt. Some measuring instruments are so calibrated when you are more interested in the difference between two values—in and out—than in the absolute power level, or output. You can always figure out the power, once the impedance is known. Of course, dbv is still a power ratio. You can argue the point, obviously, but not with me!

Instead, I have another delightful surprise for you—no matter how you read it, or what the impedance is, or what the db scale is referred to, the *difference* between readings on *any given db scale* is always accurate. −12 to −9 db on a dbm 75 ohm meter shows that the power has been *doubled* and plus 2 to plus 5 dbm on a dbm 600 ohm scale would show that the power was doubled. Notice, no mention of the impedance or scale reference. Also works, with dbv, obviously.

Here we go into the home stretch: Instant db Meter Calibration. You can learn to project a db scale on an ordinary meter with your own Evil Eye. This is useful where differences in db levels are wanted, for trouble shooting or such like. Of course, the meter should be reading ac, with no dc component. Thermocouple meters and rectifier-type meters are most suitable.

There is no zero, as such, on a db scale. The zero found in the dbm scale represents one milliwatt, of course. So we do not calibrate upscale from zero, but downscale from 100. Obviously, the first point is half voltage, −6db, at 50 on a 0-100 scale. The next half is −12 db at 25, and −18 db at

12.5, call it 12 or 13. There is a −20 db point at 10 on the scale, and the compression is such that this is the lower practical limit. We also know that −10 db, at ⅓ scale or 33 is another voltage point.

This leaves the bottom half pretty well filled, but look how empty the top half is—even if it contains only 6 db of the 20. Well: we know that 3 db is half *power,* so the corresponding voltage is the square root of this—the square root of 2 is 1.414, isn't it? This is negative db, so we use the reciprocal, 0.707 or 70 on the scale. Another method would be to simply memorize the points 90, 80, 70, 63, and 56. They correspond to −1, through −5 db.

Commercial Overseas transmitter operators use the −10 and −20 db points to set their SSB carrier suppression points. So far as I know, they are the only ones who do. I use it in shooting trouble in TD-2 Microwave receivers. The output meter has no db calibration, just an 0-2.5 and a 0-100 scale. However, the plus 10 db normal output level is usually set at 1.25 on the scale, which is also midscale (50). If this is plus 10, then 100 is plus 16 and 33 is plus 6, 25 is plus 4 and 10 is minus 4, all dbm read directly. When the reference is not known the difference readings are still useful. This knack is another baffling one for the uninitiated. Your projected scale is something like **Fig. 2**—at last, we got past Figure 1!—Of course, you can write in these figures on your own meter (I mean Figure 2 type figures, not Figure 1 type.) but this is less fun and you miss the chance to fool your friends.

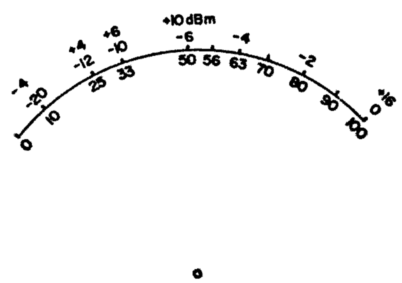


Fig. 2. See above text.

How much is plus 30? 1000, of course. So how much is 33db? 2,000 of course. Plus 27 db is, naturally, plus 20 minus 3 db, or 1000 cut in half, or 500 to 1. For more points you can use plus 6 and minus 6 db the same way—plus 16 is plus 16 is plus

10 or ten times power, times 4 for a total of 40 to 1. So between tens you can get plus 3, plus 4 (the next ten, minus 6), plus 6 and plus 7 db. Come to think of it, you can work out plus and minus 9 also, which gives you two more points. I question the worth of taking it this far, however. db to power ratios are easy, but the reverse is more tricky. Practice is the answer. And I wish more manufacturers would rate their transistors in db gain instead of just a tagless number.

Here are a few questions you can tease yourself with. The answers to them are not available, so mull them over until you are sure you are right. This way, you have fun and learn too; with the answers you stop learning. Get someone else involved, argue with him, teach him, and I'll guarantee you'll wind up with a thorough knowledge of db notation.

Problems

1. Give plus or minus db for the following voltage ratios: ½, ¼, 3, 0.5, 10, 0.1.

2. Mentally calculate the voltage gain of the amplifier visualized as follows: Input transformer, 2 to 1 voltage ratio with high side to grid. Tube, having proper bias and voltages to give a 20 db gain with an output impedance of 2000 ohms. Output transformer has an impedance ratio of 2000 ohms to 500 ohms, which latter is the output. Also with 0.1 volts input signal, what is the output voltage? And the output power in milliwatts and in dbm. Of course, the impedance ratio business is a dirty trick, but if you work this out, FCC db questions won't even anoy you; they'll be fun.

3. A precision attenuator has a 0.1 watt maximum input rating. The oscillator with which it is used has a plus 10 dbm maximum output. Does this exceed the attenuator rating?

4. Signal on your VTVM changes from full scale to 90—what is the net change in db? 50 to 80? 10 to 33?

5. 100 db is what power ratio

6. With a crystal mike rated at −53 dbm output, how much gain is required to produce one milliwatt? 10 watts?

7. 60 db is what *voltage* ratio?

8. On a meter calibrated in dbv where 0 equals 1 volt RMS, how many volts is −26 dbv?

9. The best possible level estimate by ear is plus or minus how many db from a measured value? (Accuracy, I mean)

10. A dbm 600 ohm meter, such as a VU meter connected across a 1200 ohm load reads successively −2 and plus 3 dbm. What is the net change in db?

References

(1) Who started this ridiculous dBm business? What we need is an International Committee in Charge of Leaving Well Enough Alone.
(2) You won't find it illustrated here, either.
(3) Two in all; how pauce can you get?
(4) You'll never need to get any closer.
(5) Mnemonics, yet!
(6) Nothing wrong with Peoria; the name charms me, is all. Substitute East Hernia, Unadilla or Jackson Junction if you prefer.
(7) The famous "square root of two." In each case, column 3 is the square root of the corresponding value in column 2.
(8) Note how 3.162 grows. It winds up 3162 and more.

. . . WB2PAP

International Ham Convention Knokke Belgium

The "4th INTERNATIONAL HAM CONVENTION" will take place in the Casino at KNOKKE on the 13th 14th and 15th of September 1968.

A very interesting program is being organized. It will surely satisfy the most particular radio amateur as well as the YL.

Very well known OM's have been contacted as guest lecturers about parametric amplifiers and VHF amplifiers as well as about transmitters with transistors.

Touristic visits to BRUGES and DANME —Exhibition—Stand: Mobiles—Touristic RALLY.

Furthermore: LA NUIT DE L'AMATEUR Dancing in the Wiener WEINSTUBE—Fox-hunting (direction finding)—An exercise in co-operation with the BELGIAN RED CROSS.

A unique opportunity to spend a few fine days with the YL at the Sea side.

Any OM who is interested can obtain the detailed program at the following address:

Lucien Vervarcke ON4LV
Lippenslaan 284
KNOKKE 1, BELGIUM

R. C. Kyle, K6GRP
Star Rt Box 26
Kelsey, CA 95643

More On Crystal Etching

Supplimenting Nat Stinnett's "Crystal Etching Tips" article in the April "73" I submit the following: During the past several years I have etched many crystals, since I was told, over the air, about a dilute solution of hydrofluoric acid, easily obtainable at super markets, etc.

The product is labeled "Whink" in 4 or 6 oz. brown, flat type plastic bottles, and is designated, "Rust Stain Remover." The 4 oz. sells for 75¢ and the 6 oz. for $1.00 or less, so you can have a handy safe container.

I use a little 1 oz. plastic medicinal cup or vial, easily obtainable at pharmacies or drug stores for almost nothing. They are tapered, one inch across the bottom, 1½" across the top, and 1½" deep. The curve of the sides makes it just right for the crystal, standing in the solution, to lean against the side of the cup with only the edges touching.

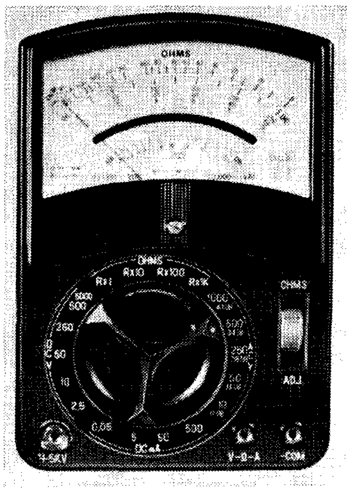
I use 2 of those vari-colored plastic picks, 3½" long, commonly used by hamburger joints or restaurants to spear into sandwiches. I make a pair of tongs with them by drilling a tiny hole through the middle of each, and threading a ⅝" piece of #22 bare copper wire through the holes as the picks are put together with the holes matching, then bending the wire over and around the picks in opposite directions, making an ideal tool for the purpose, which will not absorb the solution or water as will wood. With these you can place the crystal in the solution for etching, then remove it and swish it around in the rinse water with ease before drying it in between a piece of old sheet or shirt tail, clean and lintless.

I use the cup about ⅔ full of the solution during the etching, with a cup of rinse water alongside, and I time each dunking, and log the time required to go so many cycles, so guarding against going too far and having to try and bring it back with pencil dots.

This "Whink" solution will not etch as fast as the saturate solution, but I have found it safer in sneaking up on the exact frequency you want, without over-shooting.

. . . K6GRP

20,000 OHMS per VOLT V-O-M



DC Volts: 2.5, 50, 250, 500, 5000. AC Volts: 10, 50, 250, 500, 1000. OHMS: 1K, 10K, 100K, 1M.

DC mA: .05, 50, 500. Decibels −20 to +62 db. Few small VOM's read up to 5000 volts, yet this is just what you need for testing your rig. 3" meter with mirror for high accuracy of readings. This meter has both the low scales and sensitivity for checking transistor circuits as well as the high ranges for transmitters. Buy one for the shack and one for the car. Light and rugged for traveling.

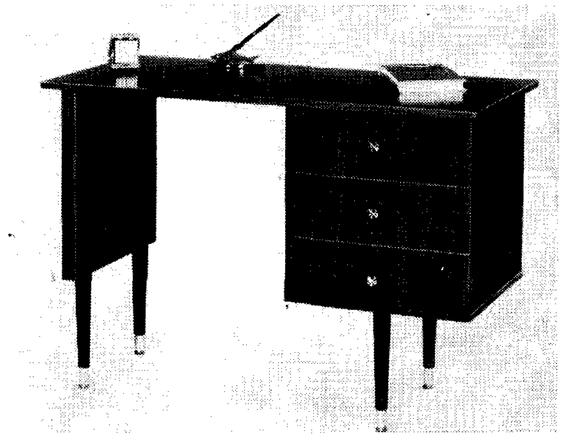
SPECIAL $9.95

plus 75¢ postage & handling

Greenville Radio Electronic Equipment Distributors

GREENVILLE, NEW HAMPSHIRE 03048

OPERATING DESK



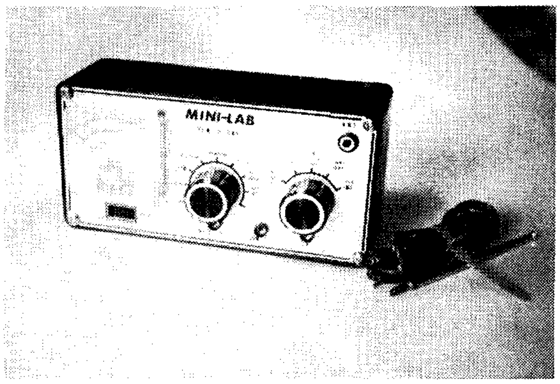
This beautiful operating desk is just perfect for the modern transceiver ham station. The desk is 28" high, and about 40" by 18" top area. It is made of Pervaneer, which is scratch resistant and almost impervious to stains, age and heat. There is a large side shelf cabinet with a swing door for power supplies and other accessories. Walnut finish. Shipped FOB Wright City, Mo. Weight 39 lbs. Also makes a fine small office desk or students desk. What a birthday or back to school present for the junior op! Assembled in minutes. USA only.

SPECIAL $24.95

Greenville Radio Electronic Equipment Distributors

GREENVILLE, NEW HAMPSHIRE 03048

TEN-IN-ONE MINI-LAB



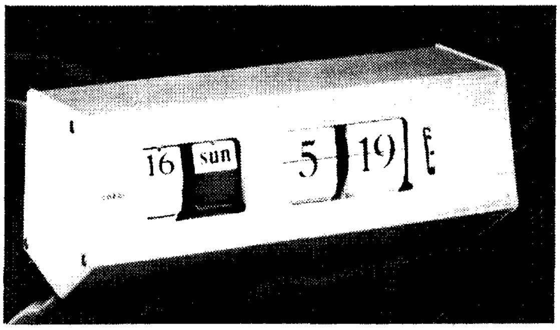
Here is a complete test laboratory all in one package! A modern miracle of electronics. This one unit contains an AC-DC Voltmeter: 50, 150, 500 volts; 0-500 mA; 10K, 100K, 1M ohms; resistance and capacitance substitution; 9 vdc battery supply; RF Signal generator 455 kHz (and up to 700 kHz); plus an audio generator at 400 Hz. You can service just about anything with this lab. You can signal trace and align receivers and trace audio systems, speech equipment, hi-fi and tape recorders. This is probably the single most useful piece of test equipment ever to come along.

SPECIAL $24.95 pp

Greenville Radio Electronic Equipment Distributors

GREENVILLE, NEW HAMPSHIRE 03048

24 HOUR CALENDAR CLOCK



This clock reads out the day, date and time in large, easy to read numbers. None of that little tiny number business for your shack. Set this up on GMT and never make a mistake again on logging time and date. 8"x3½"x3½", brushed aluminum case. Synchronous self-starting movement, 110 v 60 cycles. Make your operating desk look outstanding with this new type of clock.

SPECIAL $49.50 pp

Greenville Radio Electronic Equipment Distributors

GREENVILLE, NEW HAMPSHIRE 03048

How to Write for Service Information

Steve M. Fried K2PTS
8747 Bay Parkway
Brooklyn, New York 11214

Have you ever written to a manufacturer or supplier for information and received a half answer, or no answer at all? It is possible that the fault was not at the other end. Do not blame the other fellow until you have examined your own letter.

All reputable manufacturers strive for top customer service, but the customer often makes this aim difficult. Let us look at some of the simple rules which guarantee best results.

The most important things are how your letter looks (format) and what is in the letter (content).

Format

Always put your return address at the top of the letter. Do not write it on the envelope alone. In a large company's interoffice mail system the letter and envelope are often separated, leaving the customer service man holding a piece of paper signed "John Smith". Who is he?

If a typewriter is available, use it. A typewritten letter is more effective than the nicest handwriting. A typewritten letter in proper business form will almost always get top priority, if only because it is easier on the eyes. If you must hand write, however, print or write neatly. A sloppily written letter shows your indifference and may end up at the bottom of a large stack of correspondence.

A self-addressed stamped envelope is not necessary if you are writing to a company. If the answer will be a few words or a sentence or two, a self-addressed postal card is handy; or you may indicate that you do not mind having the answer written across the bottom of your original letter. This does eliminate dictation and transcription time, sometimes two or three days during a busy season.

Content

When you write for information about a particular piece of equipment, be sure to say what it is. Specify the make and model number, the serial number, when and where it was purchased, and how it was purchased (new or used, cash sale, trade-in, or swap). These are cut and dried facts, not a long story, so state them briefly and early. They make a good opening sentence. In the same sentence or paragraph, be sure to say what you want. Are you writing for service information, a schematic diagram, voltage and current specs, or something else? Tell them.

In the next paragraph, say exactly what is wrong and what steps have been taken to rectify the situation. For example, a customer might write this about his receiver.

"The receiver (he has already said what model, serial number, etc.) works well on all bands except 7-8 MHz, which is the third band range. Nothing is heard in this range except something that sounds like background noise. I have a transmitter which operates in this range i.e., 40 meters. I use a coax switch and dipole antenna (sketch of the hookup enclosed). The tubes in my receiver all test "good" in a quality tube tester."

The above is a pretty fair description of the receiver malfunction. Many a customer service man would suggest from this that there is something wrong with the rf input, the front end, and it has been affected by power feeding in from the transmitter. In all probability it would boil down to a burned out antenna coil. The writer gave a detailed outline of what is wrong and what is not wrong ("it works well on all bands except 7-8 MHz, which is the third band range"). This customer has helped the manufacturer to help him, by including a detailed drawing of the transmitter-receiver antenna switching system, as well as by saying that all tubes check good.

When you write letters for information, do not bother with emotion and story. It will

do no good to go into detail about how angry you are and that you have had bad dreams, and so on. That might come in a later letter, but for the time being just give him a chance to help you fix your gear. He may send a couple of aspirin tablets however, if you continue to tell him about your headaches. In short, keep it short. And to the point.

If you want to service the equipment yourself, be sure to tell the manufacturer the extent of your experience and what test equipment you have available. If you have any doubts about your ability, tell him what your knowledge amounts to and ask him if he thinks you can trouble shoot the gear in question. Remember, you might be fine on audio circuits, but what about double conversion receivers? Do you have the proper tools and knowledge? It is best to check with the manufacturer (if the service manual does not tell you what is needed). Ask him before you try an alternate method of aligning or adjusting your equipment. If your method were recommended, it would be in the manual. Remember to ask his opinion; he has spent thousands of dollars on development, engineering, and engineers.

Always try to address your letter to the proper department. If you have trouble with ham gear contact the customer service department. A person's name within the department is helpful but not necessary. Always keep a copy of the letter you have written. That way you can better understand his reply; and in case of an unsatisfactory reply, or no reply, you can forward copies of your original letter and a covering letter of explanation to both the sales manager and president of the company. (This action should only be taken when absolutely necessary).

After writing the letter

When the letter is written, go back and reread it. Better yet, have a friend go over it. Is it clear and to the point? Is it void of emotion and unnecessary detail? Have you supplied all the details of the situation? Did you give the name and number of the gear, along with the conditions of purchase? Have you described the problem and the steps you have already taken to remedy it? Did you say what kind of information you want in your return letter? Can your friend understand the letter in all details? If he cannot, start again from scratch. If he can, send it. You have helped the manufacturer help you! . . . K2PTS

Carole Allen W5NQQ
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Lafayette, La. 70501

The Care and Feeding of a Ham Club

Live wires can be dangerous around a ham shack, but in a radio club, the more the merrier! Everybody knows that a group just has to have one or more of these energetic planners and pushers known as "live wires" or "spark plugs." For some mysterious reason these folks don't mind burning midnight oil and applying elbow grease to dream up programs, head committees, type publicity releases, mimeograph bulletins and newspapers, or perhaps a joyful combination of several duties. And all this work is done to see that fellow hams get the most out of their radio club.

This is written for you wonderful live wires who are tracking down fresh ideas for a new or not-so-new club. If you're starting an organization, you're anxious to get it going on the right foot with interesting programs and side activities to attract members and their families. As a new officer of an established group you want to keep everything going smoothly; or as an experienced president or program chairman, maybe you just woke up to the fact that your sessions are sad and even the parties are painful. Regardless of your particular situation, you'll find encouragement in the material that follows.

Get it in Black and White

Publicity Chairman of a radio club may seem a simple title, but it's like DX contests and marriage, you've got to get involved to really know what it's like. The primary purpose of this job is, of course, to tell the members what's going on and when.

"Most hams have too many irons in the fire to rely on their memories," said one club official; "So, somebody's got to help."

Mailing postcards and mimeographed letters is quite effective in keeping members on their toes. Notices placed in local newspapers and spot announcements on radio and television stations are good, too.

If meetings are held weekly or bi-monthly, members usually know what's coming up, but there's still the problem of those who miss a few sessions and have to depend on word-of-mouth information that sometimes gets crossed up. Individual notification by the "printed word" is about the most dependable way of seeing that everybody knows when the picnic is being held or what time the executive committee is meeting.

Typing or writing out postcards for every meeting is simple if a group is small, but the larger it grows, the bigger the burden

One of the secrets of getting a full house at club meetings is knowing what kind of program everyone wants. Note WØFQY, Carl (The Old Man Himself) Mosley, seated just to the left of the center of the picture.

on the publicity chairman, who will soon develop a severe case of writer's cramp. Buying a postcard printer won't dent the treasury too much and will pay off in well-informed members and good attendance.

If you have up to fifty or so postcards to print you can do just fine with the Heyer Postcard Printer. This sells for $12.95, complete with a kit, in most stationery stores. You can order this by mail from Goldsmith Brothers, 77 Nassau Street, New York 10038 if you add a little for postage. This printer works on the mimeograph principle and you have to put each postcard in place and roll the stencil over it.

The Print-O-Matic postcard duplicator has an automatic feed and will run off a hundred or three cards in a few minutes. This sells for $22.95 these days and is available from Goldsmiths . . . catalog number 71YL-A2R. The Heyer is catalog #71YL-60.

The least expensive addressing machine is the Heyer Addresser. This uses the "Ditto" principle of printing. You type the names and addresses on a roll of paper using a special carbon paper. The roll will hold 250 names and addresses. You run a felt with an alcohol-type spirit on it on your envelope or card and then roll the address over the damp spot. Enough of the carbon sticks to the spirit to transfer the address. You can use this a hundred times or so before the carbon wears out. This costs $12.95, complete with the kit. Goldsmiths #71YL-100. Plus postage, of course . . . and tax if you are in New York.

Since everyone belongs to three, four, or more organizations in the community, you'd better specify that "The regular monthly meeting of the Montgomery County Amateur Radio Club will be held Wednesday evening, June 20, at 7:30 P.M. at the club house," instead of just saying "The club will meet on the regular day, etc." And for the newcomer or visitor in town, add that the meeting place can be found at the corner of South Main and Fairground Avenue.

In an additional paragraph, *sell* the club meeting and give every member a good reason to forget about "The San Antonio Kid" on Channel 5. Say, "An interesting movie on transistor circuits will be featured," or "Frank, K9HYZ, will present a short talk on building transceiver kits." Throw in an invitation to the ham's family to come along and enjoy refreshments after the program.

This same material should be included on

Meetings held in homes work out well for small groups, especially when the XYL is interested in her OM's hobby. Here is Mary, the enthusiastic XYL of Bill Jenkins W9WHL of Bedford, Indiana.

a printed sheet which can be mimeographed and then folded, stapled, and stamped. Since there will be more room on this larger sheet, don't hesitate to dress up the notice with cartoons or drawings. Even if you're far from a second Rembrandt, you can always trace something on the stencil to catch the reader's eye.

Dropping the notices in the mailbox at the right time is just as important as any other phase of the publicity chairman's job. If members aren't reminded of Saturday night's transmitter hunt until the day before, chances are other committments will already have been made. On the other hand, if notices go out three weeks before a get-together, they often find their way into waste baskets long before the big day. The publicity chairman has to be one of those fine souls who can remind himself or herself to prod the members at just the right time. This "lucky" person should have access to a typewriter, mimeograph, hectograph, or card-o-graph and accessories, including a date-book and calendar. And although this

suggestion may get a laugh at first, it's good to remember that some of the best publicity chairmen have top-notch jobs with efficient secretaries!

Where's the Meeting?

Admittedly, hams are the most entertaining and intelligent of all hobbyists, but merely sending out meeting notices doesn't guarantee a memorable gathering. In fact, if someone hasn't spent a little time making plans, the result can be a waste of time and members will wish they had "stood" at home to battle 40 meter QRM.

The where-to-meet question should take some thought, although it's true that hams can meet almost anywhere. You'll find them in basements, attics, public halls, firehouses, school rooms, police stations, storm cellars, fallout shelters, and on military bases. And they're quite at home sitting on orange crates or lounging on over-stuffed sofas.

The ideal situation is to have your own private clubhouse with a permanent station, chairs, tables, cozy kitchen facilities, and plenty of lawn space for antennas. If your club is prosperous or if the city fathers have smiled generously, the where-to-meet question is no problem. One such fortunate club is the San Gabriel Valley Radio Club in California that meets in a specially-designed disaster communications room built for them by the County of Los Angeles.

Small groups with few funds have to meet where they can and face the sad fact that few landlords want their premises wired for DX. Depending on the numbers involved, meeting in one another's homes works out very well, especially if the lady of the house likes her OM's hobby or is licensed herself. It's always fun to inspect the other fellow's shack and refreshments can be served easily. By moving from home to home, nobody's welcome is worn thin. But in case the "fireside" idea doesn't appeal to the group, you'd better start scouting. Maybe one of the gang has "pull" with a civic body that can be coaxed out of a key to the city hall or maybe to the firehouse. And don't be too shy to toot ham radio's horn if that's what it takes for tenancy. Sometimes people have to be reminded that hams are dedicated to public service and spend long hours preparing to meet emergencies, handling disaster traffic, or standing by to help someone else.

If your club is new or if you're on a committee looking for a different landlord, it isn't a bad idea to consider the activities your group will have in the future. In other words, look for a meeting place that's suited to your club. Skip the meeting room that isn't big enough for all the members and their families, too. Equally taboo are quarters so spacious that the secretary has to yodel roll call. Can a screen, film projector, and blackboard be set up conveniently? Is the ventilation good enough to keep the speaker from choking down in cigarette smoke? Are there kitchen facilities for coffee brewing?

If you use someone else's building such as the city hall, school room, or firehouse, better mark the calendar and check with the owner shortly before your meeting. There's nothing quite like barging in on the local historical society or Daughters of American Gull-watchers.

Climate also has a great effect on the type of meeting place rented, begged, or borrowed. The mobileers of Southern California may be able to rendevous at a beachhouse the year 'round, but heaven help the boys in Indiana who forget about fall frosts and winter snowstorms and rent a hall without heat.

In a nut-shell, an ounce of planning for a club meeting is sure to save at least five pounds of embarrassment.

What? No People?

If the publicity chairman does a good job and there are still a lot of empty chairs on meeting night, it's safe to say something else is wrong. How about the time of the meeting and the day of the week? Is there a regular conflict with other established community functions such as church activities, football games, or service club meetings? Sure, you won't be able to please everybody, but why pound the club's head against a wall when the meeting night just isn't working out for the majority?

Once the club has decided to meet on a certain night or nights, it had better stick to its guns and not start hopping from night to night to please the president of the Audubon Society or secretary of the book club. If members know definitely that the club meets the first and third Monday of each month or every other Wednesday, they'll work the meetings into their schedules and not miss them.

Next, consider the time of the meeting. Does it allow for working people who have to fight traffic an hour or so before reaching home? Do they have enough time to eat supper and read the paper before taking to the road again? These considerations apply to adult groups; however, if families attend meetings, the rules have to be reversed. The treasurer of the Copperstate Roadrunners, Inc., of Phoenix, Arizona, says their motto is "Fun for the whole family with the family." This means that meeting times are set early enough to allow a short business meeting and snack before the kids get too sleepy and start howling to go home.

High school students usually have a check-in time at home which should also be considered.

Another big factor in deciding how many doughnuts to buy for refreshments is whether or not XYLs and YLs attend meetings. Although OMs have worn the pants in ham radio since it started and probably always will, statistics show that lots of women are learning code and theory and getting their own tickets. Besides that, the most popular American sports and hobbies seem to be those which families enjoy together. Just because a fellow likes to have a night out now and then doesn't mean he wants his radio club to be a stag affair. The truth is that a lot of clubs would welcome women, but as pointed out by the President of the Muskogee, Oklahoma, ARC, "We just haven't been able to figure out a program to attract the ladies."

Although licensed ladies will be interested in just about any speaker or film, they usually won't attend a club meeting if they're outnumbered by men forty to one; and the XYLs without licenses are bored to tears with technical programs and can't be blamed for staying home. A discussion of phasing-type single sideband exciters versus filter-type would make about as much sense to her as a cake recipe in Greek. Obviously, the club must decide whether or not they want to plan programs to include the gals.

Clubs such as the Amateur Radio Technical Society of St. Louis concentrate on building equipment and experimenting. They keep the membership at a minimum in order to meet in one another's homes. Only social affairs are planned with wives and families. A group of this kind is exactly the opposite of the Radio Amateur Mobile Society, Inc.

known as the RAMS of Sacramento, California. Former President Leon C. Nielsen, W6QHP, says "Our formula of success is to plan all activities including the ham and his family, whether they're all licensed or not."

Both types of clubs are extremely important to amateur radio although opposite in programming. A technical society made up of members who share knowledge and concentrate on experimental projects proves the value of the amateur to the electronic industry. Similarly, the club which provides entertainment and encourages family participation in radio is equally important to the community and to the hobby.

The club should choose its goals in the beginning and decide how it intends to reach them. If members agree to have only technical programs and discussions to benefit builders and serious students of electronics, then it is understood that only those similarly interested will enjoy the meetings. A ladies auxiliary that meets in another room or holds a kitchen gab-fest while preparing snacks will enable OMs to bring their wives, while not subjecting them to technical talk.

If a vote reveals that most members would prefer a variety of programs with features to entertain and benefit wives and families, then the program chairman and officials can split the programs or make appropriate arrangements.

The secret of planning meetings for a full-house lies in knowing just what most of the members want.

More next month! . . . W5NQQ

I keep dropping those little resistors

D. E. Hausman VE3BUE

A Confined Space Nut Starter

If you have ever had the pleasure (?) of holding a nut in a severely confined space so that you could fasten it to its mating screw, you know how frustrating life can be. A simple nut holder/starter that can be used in spaces so small that your finger or a commercial nut starter would be too big, is a piece of *insulated wire*! Select a piece of wire from your junk box (the softer the insulation the better) whose outside diameter is a shade larger than the inside diameter of the nut you want to start. Carefully, screw the nut onto the wire. One turn should be sufficient to support the nut. Now you can put the nut in even the most crowded places. As long as their is enough room to get the nut where you want it, then there is enough room to get it started!

It would be wise to make a set of wires, about six inches long apiece and each wire a different size to accommodate all standard sized nuts.

Eliminating Chirp in the DX-60A

All chirp in the Heath DX-60A series transmitter during crystal control operation can be eliminated at no cost merely by relocating one wire. The problem is a result of the oscillator being keyed to facilitate break-in operation. For those not using break-in operation, the following modification can be easily made to convert to unkeyed oscillator operation.

Locate VI, oscillator tube. A resistor runs from pin 9 of this tube to a nearby terminal board. Disconnect the wire from the terminal board, leaving the end connected to pin 9 unbothered, and reconnect the wire to the ground lug on the nearby VFO input phono Jack (or any nearby ground point). This effectively removes the oscillator from the keyed circuitry. Since the oscillator now runs at all times during "Tune" and "Transmit" positions, the oscillator can be heard in the monotoring receiver but no backwave is put out on the air. VFO operation is not affected by this modification.

A SPDT toggle switch may be easily installed to switch the resistor lead either to the ground connection or to the terminal board at the option of the operator. This will give a choice of keyed or unkeyed operation at the selection of the operator.

Fred W. Fetner, Jr. WB4EFA

Why Not a Photographic QSL?

Robert C. Green W3RZD
3304 Collier Rd.
Adelphi, Md. 20783

Since the beginning of amateur radio the fraternity has been enriched by the sending and receiving of QSL cards, and now the group of QSL exchangers has grown to include CB'ers and short-wave listeners who also delight in sending QSLs. There has been one big fault with cards; that is that so many of them are alike, the only basic difference being the call-letters, the date and the name and address. This is the main reason why so many printers of QSLs are in the business, each trying to give his customers a little something different in the way of a card; something more personalized. The same thing held true for Christmas cards until the photofinishers began offering personalized cards. If you have received one you no doubt looked at it a little longer than the rest of the cards, especially if it had a picture of an old friend on it. We can take an idea from these cards and make up some personalized QSL's, and in so doing you can let your imagination run wild in the design.

There have been other articles on the subject, but to the newcomers we offer the following ideas which will make a very good looking card. First of all let's see what has to go on a card; the call-letters, signal report, equipment, name-address, and the date plus a few remarks. Sometimes there is a drawing or other imprint to set it off from other cards. In the photographic card this could be a picture of the operator, the shack, the antenna, or a map of your state, perhaps.

There are two ways of making cards; the semi-photographic and the true overall photographic card. The standard post card is 3-1/4" x 5-1/2" so everything you want to go on it has to be considered carefully, especially if a photo of your equipment is to be shown. The photo has to be large enough to show, yet not take up so much room as to leave no space for the vital information. The picture should take up about 1/3 the area of the card.

Let's say that you want a picture of your shack, the equipment and operating position on your card. Normally the equipment is arranged as you want it to appear in the picture, but look at it carefully. Does it show what you want it to show? Does the picture have composition? Does the viewer's eye strike the important points first, or does it wander around before picking out the main objects? And don't forget to clean up the place before you take any pictures. After you think you have picked the best composition for your picture, set up some flood lights. Flood lights are better than flash because the scene can be viewed through the camera's view finder under the light that will be used. Angle and top lighting are excellent because they tend to reduce the chance of getting "light kicks" in the lens); a shiny metal panel will reflect a lot of light. Don't take just one picture, take several, move the lights or the camera angle slightly. If the exposure can be varied, stop down the camera to a small lens stop and try a time exposure, painting with light. That is, hold another small flood in your hand and "paint" the area with light.

Now that you have taken the picture, decide what type of card you are going to make. Are you going to make a simple card with the picture glued on it and the information hand written or typed beside it, or a fully photographic card. If you decide on the glued-on type, pick out the best picture and have reprints made of that negative. The local drug store will be glad to handle this little detail for you at about five to seven cents each for reprints. The next step is at the post office for the blank post cards at five cents each. So far the cost of each card is nine to twelve cents, plus the labor which we can call a labor of love.

That's the first method, fairly simple and effective, but now let's go on to the regular photographic card. With a photographic card we have to work to a standard, and that standard is a rectangle. This is because of the equipment used by the photofinisher to print the cards. This time we want to make the layout 6½" x 11", twice the size of a standard postcard. The printing can

be freehand or use a set of letter stencils or the rub-on type of decal. The call letters should be about 1½" to 2" in height and the small lettering ¼" high; don't crowd, remember that it will be reduced by one-half on the finished card. Use black India ink and a lettering pen to fill in the call letters and for the small lettering. It is wise to pencil in the letters first then go over them with the ink.

If you have already taken a picture of your shack, have an enlargement made which is about 3½" x 4½" or 4" x 5" or even 4½" x 4½". The size depends on the layout you have decided on. If you want to, a Polaroid shot can be used because an enlargement will not be necessary. After you decide that "That is it", make up a new master that is free of fingerprints and smudges.

Visit the local photofinishers, (check the yellow pages of the phone book for these,) but don't go to the drug store. Tell the photofinisher exactly what you want—a rectangular negative of the master QSL, that he can handle in his automatic printer. The negative may vary from a 35mm that has to be enlarged, to a contact print that is 3¼" x 5½". But in any case let the photofinisher tell you what he can handle and what size is best. Have him show you both double weight and single weight paper for printing of cards. The double weight paper is heavier and can be mailed as is, the single weight paper requires an envelope. The author prefers double weight plus an envelope. Choose a matte finish over glossy paper because the matte finish will take ball point pen ink better than the glossy finish when filling in the date and time. If you decide to use envelopes they can be purchased for about thirty cents per hundred and by using a five cent stamp the envelopes can be mailed unsealed. The cost of the printed cards will vary depending on the number you have printed; about eight cents each for a hundred and down to about 6 cents each in lots of more than a hundred. The cost of the master negative will be about one dollar, but it can be kept and used over and over again.

If you have a friend who is a camera bug, have him take the pictures of your shack; he will have a more experienced eye for lighting and camera set-up. If he has a darkroom he could make up the master negative and run off a couple of cards for you so you can see exactly what they will look like. Don't ask him to run off a hundred or so cards or you won't have a friend.

This system of making photographic QSLs works, and works well. Try it and see, you will like the personalized touch your cards have and you will be proud to send them. At Christmas you can even make up a truly personalized Christmas QSL for contacts made during this part of the year.

. . . W3RZD-

A Report on the WTW Award

At long last the WTW is ready to roll with a report of its activity every month. Many items caused the sluggish activity of the WTW being reported in 73 every month. When Jim Fish left 73 Magazine the hunt began for all the records at Peterborough, if all the records have been found we have no way to be sure. Another very confusing factor was the Certificates being issued from Peterborough and all certifications being done in Cordova, S.C. There was always a certain lag in time between here and there and at times we both swear mail got lost between us—this made things very interesting to say the least. After spending about one month and getting all loose ends tied up we have things pretty well lined up now and everything should go smoothly from now on.

To prevent confusion please send me (Gus M. Browning, W4BPD, Route 1, Box 161-A, Cordova, S.C. 29039) all reports on WTW—DON'T SEND ANYTHING to 73 Magazine direct. I have the certificates here now and they will be sent out pronto to those who qualify. Remember I still have an ample supply of our WTW-Country/Tally sheets for the asking, send 50c to cover costs for them. They make keeping your and our WTW records a lot easier, PLEASE USE THEM. You should keep one copy and send us or your QSL check point a copy. Watch the dates of your QSO—quite a few have been coming in with the wrong date shown for the QSO—All QSO's should be AFTER May 1, 1966 0001 GMT. All QSO's same band and same mode. You may send as many over the required number and we will give you credit for every one you send and place the extra ones in your Honor Roll standing which we will publish practically every month. My records here indicate the following Awards have been issued with these serial numbers. If the number on your Certificate doesn't tally with our records please send me your certificate for a new one with the number on it that my records indicate you should have. Its a lot easier for me to change certificate than to change all my records. Only a few have the wrong serial number on them. Please check yours. Don't ask me to change my records to agree with your serial number because this could involve many others to be changed also. Now for the various Awards issued to this date (May 7, 1968):

WTW-200 14 MHz PHONE—

#1	W4NJF	Gay Milius
#2	W3DJZ	"Hop" Hopple
#3	K3YGJ	Dick Leavitt
#4	K6CAZ	Joe Butler
#5	W3AZD	Don B. Search
#6	XE2YP	Jorge P. Parada
#7	WA2SFP	James L. Lawson
#8	WA5LOB	James D. Edwards
#9	WB2WOU	Herbert Rugoff
#10	W1MMV	G. W. Cunningham

WTW-200 21 MHz PHONE

#1	W4OPM	Joe Hiller

WTW-100 28 MHz CW—NONE

WTW-100 28 MHz PHONE

#1	WA2SFP	Jim Lawson
#2	W4GJO	Ansel E. Gridley
#3	W5YPX	J. B. Jenkins
#4	WA5LOB	James D. Edwards
#5	W2VBJ	Harry J. Marschausen
#6	WA5DAJ	Leonard P. Malone

WTW-100 21 MHz CW

#1	W4OPM	Joe Hiller
#2	VE6TP	Gene H. Krehbiel
#3	WB2UDF	Douglas J. Gorga
#4	WA6GLD	Frederick J. Hagen

WTW-100 21 MHz PHONE

#1	WA2FQG	Ted Marks
#2	WA2SFP	James Lawson
#3	W4OPM	Joe Hiller
#4	K9PPX	Scott G. Millick
#5	W6YMV	Paul E. Friebertshauser
#6	WA4WTG	R. Robert Kaplain
#7	W9NNC	Don Misch

#8	WA5DAJ	Leonard P. Malone, Jr.
#9	W8WRP	James Horvat
#10	WAØOAI	George C. Blunck
#11	WB2OBO	Jess Miller
#12	WA5LOB	James D. Edwards

WTW-100 14 MHz CW

#1	WA2DIG	Vice Ulrich
#2	W8EVZ	James Resler
#3	K8IKB	Dan Redman
#4	W4CRW	Robert C. Sommer
#5	WB6SHL	John Scanlon
#6	W9HFB	Newton K. Gephart
#7	W5ODJ	Fred A. Fisher
#8	WB2TKO	William Meeker
#9	WA9KQS	Edward F. Bauer
#10	W1ETV	Moulton Larmay
#11	K5BXG	Charles E. Calhoun
#12	K4ASU	Robert C. Webb
#13	WA6GLD	Jerry Hagen
#14	WB6NWW	Marty Hartstein

WTW-100 14 MHz PHONE

#1	W4NJF	Gay Milius
#2	W5KUC	Bob Wagner
#3	W3DJZ	"Hop" Hopple
#4	W4CCB	Bob Gilson
#5	WA2SFP	Jim Lawson
#6	K6CAZ	Joe Butler
#7	WØNGF	Warren Johnson
#8	W3MAC	Lew Papp
#9	K1SHN	George Banta
#10	K8IKB	Dan Redman
#11	W6YMV	Paul Friebertshauser
#12	W1SEB	Jay Chesler
#13	WA5LOB	James Edwards
#14	W4TRG	Bill Galloway
#15	WB2NYM	Olgierd Weiss
#16	KP4RK	Jose Toro
#17	W1MMV	Gerald Cunningham
#18	WA9KQS	Edward Bauer
#19	WA4WIP	Dick Tesar
#20	W4FPW	G. Gus Brewer
#21	K9OTB	Jack McNutt
#22	W4JVE	Charles R. Sledge
#23	DL5HH	Ira C. Crowder
#24	W4FPS	James Leonard
#25	K3YGJ	Richard Leavitt
#26	VE6AKP	Gordon Read
#27	K2BQO	Paul Haczela
#28	W3AZD	Don B. Search
#29	WA5DAJ	Len Malone
#30	OZ3SK	Egon Gadeberg
#31	ZL3OY	G. Coull
#32	K4RZK	John F. Berryman
#33	CN8FC	William T. Broder
#34	WAØOAI	George C. Blunck
#35	WØSFU	Bob Parlin
#36	W4HA	John McCaa
#37	ZL3MN	J. T. McMullan
#38	W3NKM	Stanley S. Springer
#39	W8WAH	Ray Slater
#40	VE3UR	Ray Hunter
#41	VE3ELA	G. L. Clark
#42	WA4WTG	R. Rober Kaplan
#43	W6MEM	Stephen M. Stambuk
#44	WA2OEQ	C. C. Unrah
#45	WB6RMZ	Dwain Schunke
#46	K5BXG	Charles E. Calhoun
#47	WA4OPW	William G. Rogers
#48	W8BVF	Jim Lancaster
#49	W6OHU	Murray H. Link
#50	W8FPM	Hugh K. Cotton
#51	K2QOU	C. Buchheit
#52	VK3XO	L. A. Paul
#53	VE6AKV	D. C. McKoen

WTW-100 7 MHz CW

#1	W4BYB	Rex G. Trowbridge
#2	W3WJD	R. Sigismonti
#3	W8ZCK	Bill Price

That wraps up the WTW for this month. How about some additions to your scores for the Honor Roll next month? I will accept any number of cards to check, provided you send along a stamped return envelope. We want a good competitive standing in the WTW Honor Roll. Please date all correspondence and give your call sign and WTW certificate number in every letter to me. . . . W4BPD

Radio Amateur Rockhounds

R.A.R. for short

Are you interested in rock collecting or exchange, or semi-precious stones or information about this hobby?

Robby, 5Z4ERR (E. Robson M.P.S., Box 3077, Nairobi, Kenya) is president of a new club for Radio Amateurs only. Do you want to sked and meet any R.A.R.s on the air?

To join, send your address and a SAE and postage and you are in!

After a breather, Robby will circulate a list of call signs and suitable frequencies and time to hook up on 20 meters. If enough hams join in, it can be decentralized and the Ws, VKs, ZLs, and S. Africans can get together with their own groups as well as on an international basis.

Liasons Needed

We need amateurs in Tucson for liason with APRO, in Washington, DC for NICAP, in Boulder for the Air Force Project, and in Pittsburgh to contact the UFO Research Institute. The Instutite has a 24 hour a day answering service and is attempting to get a team to any sighting within 200 miles of Pittsburgh.

Organization Schedule

Perhaps it is time for those interested in the founding of the UFO network to get together for some preliminary organization discussions. Let's meet on 14,300 on Wednesdays evenings at 0200 GMT and see who is there, what suggestions they have, and what plans can be made. The time would seem to be a reasonable compromise, being 7 pm in California and 10 pm back east. Propagation conditions may make communications a problem between some of the stations, so perhaps we should try 3950 on Thursday evenings at the same time and see how we do there.

YOU CAN HELP

Thousands of amateurs around the world would like to be reading 73, but either the subscription price is beyond their means or else their governments won't permit them to send money out of the country. You can help spread the amateur spirit through a gift subscription. We will send a gift card in your name to the recipient.

__$5 enclosed for a one year subscription.
__$10 enclosed for two one year subscriptions.
__$25 enclosed for six one year subscriptions.

Please list the name and address below (and call) of the recipient(s). If you have no one in particular in mind please check the following so we can follow your preferences.

__Asia
__Africa
__Russia
__other . . .
__ARRL Director (12 out of 16 Directors do not subscribe to 73). You can help them get 73 so they can keep up on current events and better represent their constituents. They might be interested in keeping up with the latest technical developments too. Help these fellows out.

(*W2NSD/1 from pg. 4*)

In addition to exposing amateur radio to the general public in rather large masses, the early May ham gathering in Paramus brought together a goodly number of VHF amateurs. The big drawing card was Ray Naughton VK3ATN, flown over by Quantas Airlines by arrangement with the Garden State Shopping Plaza. Ray is the chap who has been setting the two meter worlds records via moonbounce.

I visited Ray during my short visit to Australia on my round the world trip a bit over a year ago. He'd kept after me every time I got on the air from a new country and by the time I arrived in Australia the details of my trip to Birchip, Victoria had been worked out. It meant cutting a day off my visit to Sydney, which, unfortunately, the chaps in Sydney took with bad grace.

From Melbourne I took a train north to the end of the line in Bendigo. There I was met by two local hams. They popped me into their car and drove me about 50 miles across the flat countryside, much like Kansas, to a small town where we met Ray. Ray drove me another 20 miles or so and then changed me to the car of a friend of his who wanted to meet me and we drove on to Birchip. Ray lives on the outskirts of a small farming town and, looking out his back door, there were antennas as far as I could see. Towers were all over the place. The most remarkable of all was his 50 wavelengths long two meter rhombic system. Ray is on all bands and can work anyone in the U.S. that has a reasonable signal on 160M, 80M, 40M, 20M, 15M and 10M. He'll be on six one of these days when he gets a better location for his rhombics, one a little further from the power lines.

Ray played tapes of his moon bounce echoes on two meters for me. They are excellent echoes. That evening we got on 75 meters and worked back to W2NSD/1 with S-9 plus signals both ways. Now that was a thrill I won't ever forget. Then we shifted up to 20 and my home rig was booming through about 40 over 9.

We talked ham radio and Ray's plans and accomplishments on into the night. The next morning I had to get moving on again. Ray had arranged for a small private plane to take us up to a town in New South Wales, Griths, where I met a commercial plane that took me on to Sydney. It was a fascinating flight and I had a chance to see first

hand the amazing water transport system they use to water just about all of Victoria and most of New South Wales. The water travels along hundreds of miles of open ditches, gravity flow with about 6″ to 9″ drop per mile. There is a heavy loss due to evaporation and they calculate that only 15 gallons of every hundred manages to get to Birchip.

When Ray found that he was going to get a trip to the States he wrote to me and I quickly invited him to return my visit. Ray did get up here for a visit and he brought me up to date on his two meter accomplishments . . . and they are considerable. He had been active on two meters for several years and pretty well worked what there was to work around Australia. He was looking for more to conquer. He had read several articles about moonbounce and had been kind of mulling it all over in his mind. Then one day he was driving on a long trip and was talking with Sam, W1FZJ/KP4 down in Arecibo, the grandaddy of moonbouncing. Ray had been thinking about trying a long rhombic for two meters and Sam encouraged him to get going on it, saying that he was sure that it would work. Sam has problems, but being technically wrong isn't one of them, so Ray got to work researching the literature on long long rhombics. The QSO with Sam was in November 1965. The researching lasted through January 1966 and in February Ray started putting up his antenna. It was 50 wavelengths long and consisted of two stacked rhombics, a full wave apart. He figured that if he aimed the rhombic at a spot in the sky where the moon would pass he would have a few minutes a month when he would be able to bounce signals into the States.

On March 28th, 1966, Ray fired up his 150 watt rig, the power limit for Australia, and sent out signals toward the moon. The receiver was an Ameco Nuvistor (6CW4) converter with no preamplifier. Back came the echoes. Weak, to be sure, but there was no question about it. I've heard the tape he made of that historic night. A couple nights later Ray was listening for K6MYC and heard him coming through very weakly.

That really got Ray going. He decided to put up two more rhombics in the stack. This should give a gain of about 34 db, about equivalent to a 2500 element collinear antenna. He added a preamplifier and a noise blanker. He also put up a series of arms

on the lead tower so he could skew the whole rhombic a few degrees one way or the other to give him a couple more days or so a month.

When I arrived in September 1966 Ray had several good tapes of K6MYC, but Mike had yet to copy his own signals from the moon or to hear Ray. He was working at it though. The big schedule was set up for the 28th of November, the next time the moon would be in the right spot. The boys from K2MWA called in on 15 meters and asked if Ray would listen for them and Mike sat there in California hearing both sides of the QSO while K2MWA made the first U.S.-Australia two meter contact. That must have been about the last word in frustration. In December, when the next chance came, Mike was there and made it a second state for Ray. Mike was operating portable at Stanford University using a 320 element beam.

The 320 element beam was split up in 1967 with half going to WB6KAP and the other going home with K6MYC. In December 1967 Ray worked Mike at his home QTH using the 160 element beam. Ray has heard WB6KAP several times, but KAP can't yet hear his own echoes and hasn't been able to hear Ray.

Ray has also heard W6YK, who is using four 8 over 8 J slot yagis. YK can't hear his own echoes and has yet to copy Ray.

In February 1968 Henry, KØIJN up in Minnesota put up a big collinear, hooked up the transmitter and receiver, and proceded to work Ray the first time on. He started out sending CW at about 20 wpm, but then found Ray sending back at the normal moonbounce high speed of about three wpm and slowed down so Ray could get his signals through the fading.

Ray is hoping that a lot more states will come on with adequate moonbounce signals so he can get his WAS certificate. Or even his WAAS (Worked Almost All States).

K6MYC is using the Cushcraft collinear antenna. While visiting up here Ray had a chance to stop and visit with Les and Bob Cushman at their plant in Manchester, New Hampshire. He let them hear the tapes of the signal from the Cushcraft beams as heard in Australia. Ray was quite enthusiastic about the new Cushcraft two meter combination collinear antenna with a director on each bay. This makes each 16 element colinear bay end up with 20 elements. They

apparently find that this makes for much better matching than the double directors they had made for me for use up on 73 Mountain a few years back.

Eight of these 20 element sections will give you all the gain you need for good moonbounce signals, according to Ray. He should know. This certainly puts moonbounce operations right down where a lot of VHF men will be able to participate. Cushcraft has all the matching and phasing sections available, so the real hard work has been done for you. Watch the Cushcraft ads for an announcement of this new collinear with director elements. If you put your antenna on a moveable mount you will be able to moonbounce every day, though you'll have to wait for the two days a month that the window is open to Ray (24 minutes each day).

Even the rig isn't much of a problem any more. Ed Clegg tells me that he expects to have a good solid very full kilowatt rig on the market by the end of this year for two and six meters. A lot of us will be looking forward to that one.

Speaking of six meters, Ray feels that there should be little problem in bouncing signals off the moon on six meters with a rhombic. As soon as he can find a spot far enough away from the power lines to keep the local noise down he is going to get set up with a nice six meter rhombic. Before long you'll be able to work Ray on eight amateur bands.

Ray has given me the full particulars on his two meter rhombic and I will write it up for those of you who have a few acres sitting there in need of some fancy antennas. Actually it isn't all that hard to get up in the air and tune up. It took Ray about a month and his resources are meager when compared to those up here in the States. Ray has had to do everything the economical way, being just as short of money as most of the rest of us. He runs a small applicance shop in Birchip, a town of about 1000. This makes for a comfortable, but not extravagant, living.

This trip to the States is Ray's first experience as a traveling ham and he is finding out how wonderful the hospitality of hams everywhere really is. He's been shuttling from ham to ham, rarely let go to bed before 2 am despite rising times usually around 6 am. When he visited here he had to get up at six to catch an 8 am plane up

here. It was the only flight of the day. It was worse when the two of us left here and flew out to Rochester for the VHF Conference. The plane left Boston at 7:20, so we had to get up at 4:30 to make it.

Rochester

They had a marvelous crowd there. Though they had a full schedule of speakers they worked in a good spot for Ray and he held one of the largest audiences of the day spellbound with his talk and the slides of his antenna farm.

The number of fellows that stopped by the 73 booth to say that they would be coming up to see us on July 6th for our hamfest was more than encouraging . . . it was almost frightening. If that many are coming from as far as Rochester . . . how many may be here in total? I think we're going to have a ball.

Though I expected only a small turnout of saucer devotees for my own talk of the day on our UFO Net, I was surprised to find the large room filled to standing capacity with an interested and enthusiastic audience. I explained about the sorry state that our government has left UFO research in and how much amateur radio can do to help this miserable situation. It is one of the greatest opportunities for contributing to our country that we have ever had.

Jim Sipprell K2HYQ, the local representative for NICAP (National Investigations Committee on Aerial Phenomena) contributed the most interesting part to my talk by showing slides of some of the most carefully authenticated UFO photos. Any ham clubs within driving distance of Kenmore, N.Y. would do well to get in touch with Jim and get him to bring his program to your next club meeting. Write Box 209, Kenmore.

The Anatomy of a pile up

Edgar Wagner G3BID
5, Ferncroft Avenue,
London, N.W.3.

The "Pile Up" is, of course, a well known phenomenon on the amateur bands, and one which one expects if one goes to operate from a relatively rare country like ZD3 or 6W8.

It was, therefore, particularly interesting to study this phenomenon from these countries.

The first point which strikes the visitor to a rare country is *not* the pile-up itself, which one expects, but the extraordinary fact that one can pick a clear channel and call CQ, and have no one come back. Of course this clear channel may appear to be clear from the DX station locality, but need not be clear at the other end. To try to eliminate this factor, I frequently called CQ on *various* frequencies for up to half an hour when the band was clearly open. Nor can it be argued that I was not getting out, because at the end of half an hour a station came back and this soon developed into a pile-up.

It has frequently been observed that pile-ups are virtually self-generating. That is, if the station is calling and getting no replies, it is often left to call and get no reply at all. Once several stations are calling, the pile-up generates itself.

This leads to the conclusion that many amateurs are unwilling to tune the band for a possibly rare station but are attracted to the frequency because they hear a pile-up. Further testimony that many amateurs chase the "pile-ups" rather than chasing DX, is how often one hears "QRZ the DX station on the frequency" in the middle of a pile-up. Clearly the operator had not heard the DX station and merely noticed a pile-up and immediately been attracted—not by the DX station, which he hasn't heard—but by the pile-up, which he had heard.

Some time ago I was operating G3BID/CN/M and heard four Americans discussing me. One stated that he heard that G. . . would be operating Mobile in Morocco and asked another if he knew when he would be on. Another asked what bands the station was expected to operate on, as he was keen to work the Mobile in Morocco. They passed it round so fast that although I was listening on the frequency and repeatedly tried to break in they never gave me the opportunity, and after about a quarter of an hour or twenty minutes listening to them saying how anxious they were to work me, I had to move off the frequency as it was quite hopeless to try to break in.

There seems to be a curious pride with some operators in seeing how fast they can pass it round without a moment for a DX station to break in.

One of the best examples of Pile-ups was when I heard of a pile-up on an EA8 while I was operating from ZD3. Very few contacts were made as the EA8 could not pick out the calls from the pile-up. I chose a clear channel 7 kHz above the EA8's pile-up and called CQ, hoping to thin out the EA8's pile-up and so enable the stations to work both the EA8 and ZD3. By all normal calculations ZD3 is rarer than EA8. Nevertheless I did not get a single reply to repeated CQ's only 7 kHz above the EA8 Clearly the callers were attracted to the "pile-up" rather than to the station.

It would be an interesting experiment to "organize" a pile-up on top of some quite common call, and see how much of a pile-up one could generate from almost nothing because it does seem clear that it is the pile-up itself which attracts many callers.

I notice too, how quickly a pile-up disintegrates if one switches to split frequency operations. There may have been twenty or more stations calling on the frequency; one announces that one will listen 10 to 20 Hz higher and in the whole 10 Hz only three stations are heard. I realize that some people can only operate transceive, but not as high a proportion as that surely.

Curiously enough while it is very difficult to get people to call 10 or 20 Hz off the frequency, there are also many operators who cannot or will not zero the frequency accurately when one is operating transceive. Quite a few stations seem to find great difficulty in accurately zero-ing a frequency.

It is understandable for a station to call 2 Hz or even 1 Hz off the DX stations

frequency in the hope of being heard, but surely no one *deliberately* calls ½ Hz or ¼ Hz off the frequency. One is left with the only possible conclusion that these people are *unable* accurately to zero on to the frequency. It was surprising how often when working transceive with quite an orderly group calling me after each QSO, for quite a high proportion to be just far enough off frequency to necessitate re-tuning to their frequency and so moving the transmitting frequency or having great difficulty in copying.

One wonders that the licence examinations include no "practical exam". Clearly, this point of accurate zero-ing is totally neglected in the licensing examination, since, —apart from the Morse Code test—the examination is purely written.

If the Code test is a "practical examination", might not a "Netting" or "Zero-ing" test be a good idea.

I noticed with interest that the more difficult tests and exams in the U.S.A. for the "advanced" and "Extra" class included a higher standard of Theory and of Morse Code "practical" test, but no "practical" test of handling the equipment.

Many complaints can be read in the magazines about "Appliance Operators", but the official licensing tests do not even include any practical test of the ability to operate the appliance. . . . G3BID

D. E. Hausman VE3BUE

Keeping Contacts Clean

Solid state gear is becoming ever more popular. Where current was once measured in milliamps, it is now measured in microamps. As a result, it is imperative that relay and key contacts be kept clean. Otherwise, erratic operation might result.

A simple way to keep your contacts clean is to use a small automotive file used for filing spark plug gaps. The teeth on such a file are very fine and remove only the dirt from contacts. This file is available at most auto supply stores for about twenty-five cents.

A further method of keeping contacts clean in the long run is to cover your key or relay with a small plastic container.

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

Getting Your Higher Class License

Part IV — Antennas, Transmission Lines and SWR

This is the fourth installment of our study course for the new Advanced Class license examinations. In previous installments we have examined radio waves, propagation, single sideband, and some principles of transmitter design, construction and operation.

In the process, we have gone through 15 of the 51 questions on the FCC study list.

This month, we're turning our attention to a subject of general interest to everyone—whether he is studying for a new license or not. This time, we're looking at antenna matching, transmission lines, and SWR.

Some of this material was brushed across lightly in our first installment (radio waves and propagation). Because of this, we can take on more than our scheduled five questions this month. The study list includes seven questions dealing directly with antenna adjustment, matching, and feeding, which we haven't already examined, and we'll take them all.

The specific questions we're looking at this month (numbers are from the FCC study list sequence) are:

2. What is a good indication that a high standing wave ratio (SWR) is present on a transmission line? Where is the best point on a long, transmission line measure the SWR?
4. What happens to the voltage, current, and impedance along a transmission to line with a SWR of 1?
11. A transmission line that feeds an antenna has a power loss of 10 dB. If 10 watts are delivered to the transmission line input, how much power is delivered to the antenna? List possible causes of power loss. How can the SWR of the line be made as low as possible?
29. When can a low-pass filter be installed in a coaxial cable without causing a large power loss?
30. How can the resonant frequency of an antenna be increased? Decreased?
31. A 70-ohm half-wave antenna operating on a frequency of 7300 kc is to be matched to a 50-ohm transmission line. Calculate the characteristic impedance of a quarter-wave matching section and the physical length of the antenna at the frequency given. What is the SWR between the antenna and transmission line without a matching section?
45. What are the advantages and disadvantages of using the same antenna for receiving and transmitting?

As usual, we'll paraphrase all these questions into another group of questions to spotlight the technical points involved, and then examine the resulting "general" questions rather than the detailed problems presented by the study list. An understanding of the principles will permit you to solve any specific problems if the necessary details are provided.

Four of the seven questions deal directly with "SWR" while a fifth one requires a knowledge of SWR for its answer. Therefore our first "general" question must be, "What Is Standing-Wave Ratio?". Equally important is the second: "What Are The Effects of SWR?"

Two of the questions deal with facets of "matching" between transmission line and antenna. A third "general" question, then, is: "How Can Lines and Antennas Be Matched?"

To wrap up the discussion, and to permit us to deal with questions 11 and 29, we must ask: "How Are dB Related to Power Loss?", and question 45 may then be examined without need to paraphrase it.

We thus have reduced the seven original questions to five, but the answers to those five will provide the tools necessary to answer the original seven as well as all other questions of similar nature.

SWR

What Is Standing-Wave Ratio? To determine just what "standing-wave ratio" (which we will henceforth abbreviate as

SWR) is and how it affects antenna performance, we must back up a bit to matters discussed in the first installment and look at a "standing wave".

Remember that a radio wave is propagated by the fields which result as current flows through an antenna. While we looked at only the field produced by a single point of current flow along the antenna, it takes little imagination to realize that every one of the points along the antenna wire has its own current flow at any instant, and that all of these currents are continually changing.

The situation is very much like a long water pipe connected to a piston-type pump at one end, with the other end stuck in a pond. When the piston pushes, the water in the pipe is pushed away from the pump and toward the pond. When the piston pulls, the water is sucked back from the pond toward the pump.

In a pump, of course, you have a valve which eliminates either the "push" or the "pull" so that the water moves only one way. The propagation of rf energy down a feedline (or up a feedline) is more like a child blowing into straw and sucking liquid back up.

The top line (1) in **Fig. 1** shows this situation, with the piston at the left of the illustration. The figures in the drawing represent "pounds of pressure" and the arrows indicate its direction. If the piston is capable of producing 10 pounds of pressure, the pipe at any instant will have points within it at which 10 pounds of pressure is moving away from the pump, other points at which a corresponding 10 pounds of pressure is moving toward the pump (pull), and halfway between these points of opposing maximum pressure will be points at which the pressure is nothing at all, 0 pounds.

If the pipe is the same inside diameter all the way from the piston to the pond, this pattern will also be the same for the entire length of the pipe.

However, if we run out of large pipe halfway to the pond and put in a reducing joint so that we can finish the run with smaller pipe, the picture changes. This is shown by lines 2 through 5 of **Fig. 1.**

The piston can still produce 10 pounds of pressure; the smaller pipe, though, can accept only 7 pounds of this pressure. The other 3 pounds has to go somewhere; with no place left to go when it reaches the reducing joint, it has no choice except to

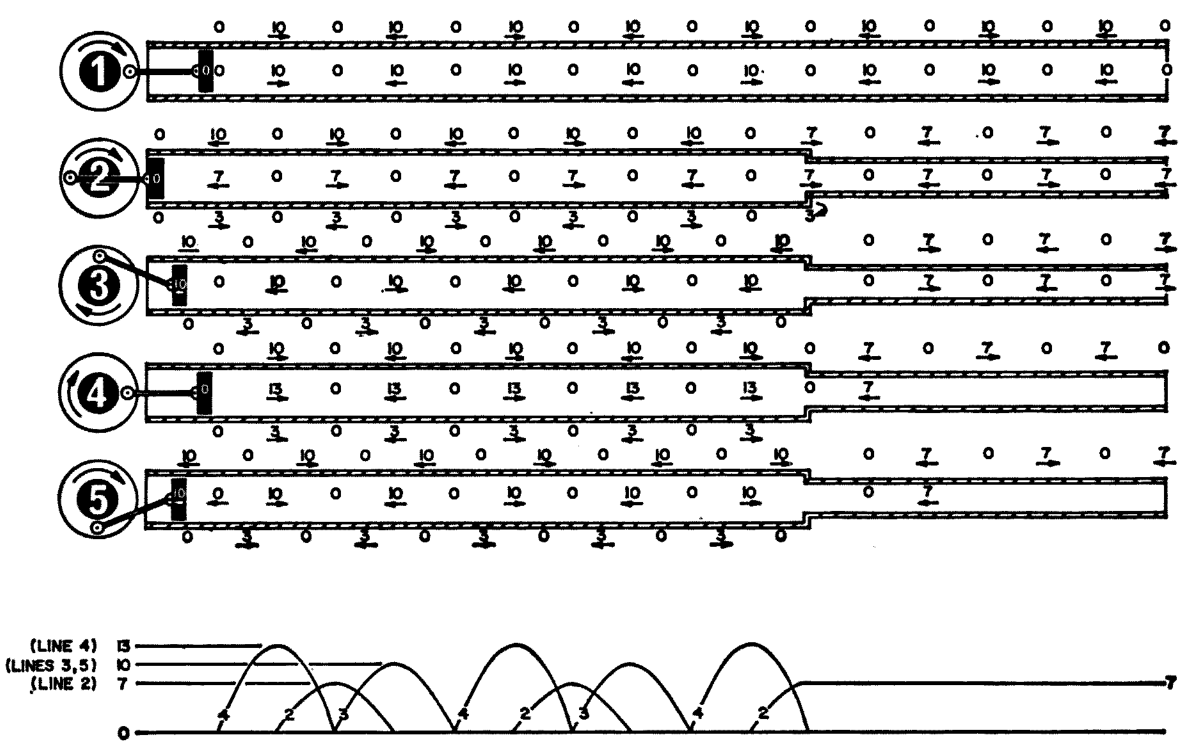


FIGURE 1—RF energy flowing in a transmission line may be compared to water being forced down a pipe by a piston. Line 1 shows the comparison for an unencumbered pipe. Lines 2 through 5 show what happens when the pipe suddenly gets smaller; some of the pressure turns around and pushes back. See text for explanation in detail.

turn around and come back to the piston.

This means that each forward "push" of the piston imparts up to 10 pounds of "forward" pressure to the water inside the pipe, but up to 3 pounds of "reflected" pressure which has gone the distance from the piston to the reducing joint and back again is bucking against the "forward" pressure.

At some points in the pipe, and at some times during the push-pull pumping cycle, both the "forward" and "reflected" pressure waves will be moving the same way. This is shown in line 4 of the drawing. When this happens, the two add together to produce 13 pounds peak pressure.

At other points in the pipe, and other times during the cycle, the two pressure waves are going in oposite directions. Line 2 shows this effect. When this occurs, the smaller cancels out part of the larger and only the difference is left, moving in the same direction as the larger of the two original waves.

Any time that the two waves do not either completely add (as in line 4) or completely subtract (as in line 2), they modify each other in a more complex manner. Lines 3 and 5 show two examples of this occurrence. In line 3, for example, the piston is moving forward at maximum pressure. Between the face of the piston and the first zero-pressure point of the forward wave, the pressure decreases gradually from 10 pounds to zero. In the reflected wave, a zero-pressure point exists at the piston face; from there reflected pressure climbs until it reaches a maximum of 3 pounds at the same place in the pipe as the forward-wave's zero-pressure point.

It's fairly clear that at the piston face, the total pressure is the sum of 10 pounds forward and zero reverse, or 10 pounds forward. At the forward wave's first zero-pressure point, the total pressure is zero forward plus 3 pounds reflected, or 3 pounds reflected.

The forward and reflected pressure waves are moving in opposite directions, so *somewhere* between the piston face and the first zero-pressure point of the forward wave the total pressure within the pipe must pass through zero pounds. This happens when the forward and reflected waves are of exactly equal strength; at this point they cancel each other out.

As we examine the line on beyond the first total-pressure zero point we have just located, we will find that the forward wave is "pulling" at the same time that the reflected wave is "pushing" so that the result is a pond-toward-pump wave stronger than either wave alone. This total pond-toward-pump wave reaches its maximum pressure just before the reflected wave drops to zero pressure since the forward wave, which is much stronger, is increasing in pressure more rapidly than the reflected wave is falling.

This process continues the length of the line until the reducing joint is reached.

Line 5 shows a similar process; the only difference is that we are looking at a difference point in the pump cycle, and so the push and pull relationships between the waves are reversed.

Now let's imagine that the pump is speeded up tremendously, so that we can no longer visualize the individual points of peak "push" and "pull" pressures. They will still interact just as we have seen, but when we attempt to measure pressure inside the pipe at any point we will get a reading which is the *average* or *effective* pressure at that point, and which is the product of many individual wavefronts and their interactions.

When we do this to the unencumbered pipe shown in line 1, we find an even 10 pounds of pressure all the way along the pipe.

When we attempt it with the restricted pipe shown in the other lines, however, we will find an even 7 pounds of pressure in the smaller pipe. In the larger pipe, though, we will find that the pressure reading depends upon the point at which we take our measurement!

Right at the reducing joint, for instance, we will read an even 7 pounds just as in the smaller pipe. As we move back toward the pump from there, we will find the pressure increasing until it reaches a maximum of about 13 pounds. Then it decreases until it gets back down to 7 pounds, and begins rising again.

The pressure variations themselves, then, follow a "wave" pattern in a cycle—but this wave is not in motion; it's standing still. And for that reason, it's called a "standing wave".

When we deal with rf rather than water in a pipe, it's actually a little more complex than that, but the principles are the same. The standing wave is created by in-

teraction between the "forward" wave going from the transmitter or other source out to an intended destination, and a "reflected" wave which bounces back from any restriction or "discontinuity" in the line.

If the discontinuity is minor—that is, if almost all of the available energy can move past it in the "forward" direction and only a small portion is "reflected" back to the source—then the reflected wave will be very small compared to the incident wave and the resulting standing wave will also be small.

If the discontinuity is large, so that much of the available energy is reflected and less continues in the "forward direction", then the standing wave will be large.

In the extreme example of an open-circuited or short-circuited line, where the energy has no place to go and so must all be reflected, the standing wave will be as large as the available energy permits.

Some method of measuring the strength or size of the standing wave is necessary, and that's where SWR comes in.

A "small" standing wave will show very little variation between the voltage at its "maximum" points and that at its "minimums". A large one, on the other hand, will show a large variation. The *ratio* between the voltage at a maximum and the voltage at a minimum thus provides a measure of the "size" of the standing wave. This ratio *is* our old friend SWR.

In the days of open-wire feeders, SWR was actually measured in just this manner, using an rf voltmeter. This procedure was noted for its tendency to produce rf burns; the voltage at a maximum with a high SWR can easily run into the kilovolts!

Fortunately, SWR can be measured by simpler means. The "directional coupler" and its cousins are among the simplest. These are instruments which employ some special coupling and phasing circuitry to separate the "incident" and "reflected" components which are present at the same time in the same feedline, permitting you to measure each component individually. Since the ratio of forward energy to reflected energy is what actually creates the standing wave, a knowledge of this ratio (called the "reflection coefficient" by the engineers) permits a calculation of the SWR. This calculation is made by special calibration of the dials on today's SWR meters, virtually all of which use the directional-coupling principle.

We have seen, now, that *any* discontinuity in a line carrying rf energy creates reflections of the energy, and that these reflections create standing waves which are measured by SWR. Before we move on to examine the effects of a high SWR, we should note that the most common cause of such discontinuities is an impedance mismatch between feedline and antenna, and that improper installation or maintenance of the feedline runs this a close second in the "most common" list. If, on the other hand, a perfect impedance match is obtained, no reflections can result since no discontinuities exist. In this case the voltage, current, and energy will remain essentially constant at all points along the feedline, and the "SWR" will be 1.0 since the "maximum" and "minimum" points are at the same voltage.

We should also keep in mind that 1.0 is the best possible SWR. Anything *less* than 1.0 is not possible, because this would mean that more energy was being reflected than came up the line in the first place! Even if a reading of "0.7" could be obtained, it would refer to the same SWR as would a reading of "1.4", except that you would be looking in the opposite direction along the line (from load to source rather than from source to load).

What Are the Effects of SWR? Now that we know just what SWR amounts to, we are ready to examine its effects. The major effects of standing waves fall into three categories:

Most important, at the antenna, is that a standing wave permits energy to radiate, and is in fact necessary to permit radiation. While this is a desirable effect at the antenna, it is most undesirable anywhere else. You want the energy to get *to* the antenna before it is radiated! Anything lost by radiation on the way is just that much power lost.

The remaining two are two sides of the same coin. A high SWR means, by definition, that the voltage across the line has values at some points along the line which are much higher than those at other points along the line, since SWR is simply the ratio of these maximum and minimum voltages. When a high SWR exists, so do points of unexpectedly high rf voltage. These high-

voltage points can damage equipment, and even injure you.

At the points where voltage is high, current must be low, since the power put into the line remains constant. Similarly, where voltage is low, current is high. These high-current points also cause trouble. They can vastly increase your power losses in the line, since power lost is equal to current *squared* times resistance. If the current is 10 times as high as expected, the power lost is 100 times greater. With an SWR of 10 to 1, which is not uncommon in badly matched lines, power losses can be expected to be around 100 times greater than expected.

This high power loss produces excessive heat at the points of maximum current; the feedline may actually be melted as a result. The current effects, then, produce both a loss of power and possible damage to equipment.

The undesired radiation due directly to the presence of the standing wave, and the increased losses due to the current peaks within the line produced by the standing wave, are the two most major effects normally noted from a high SWR.

Several other effects, which result from the abnormal voltage and current patterns caused by the SWR, are not so frequently attributed to standing waves—except by persons who really understand SWR. One of these is high power loss in low-pass filters.

A filter, to perform its function properly, must be operated exactly as its designer intended. The function of a filter is to introduce extreme power loss at certain frequencies, while having very low losses at other frequencies. Those frequencies lost in the filter are "filtered out" while those not affected become the normal output. To do this, the filter must "see" the proper impedance level at both its input and output terminals. If an improper impedance is present, the high-loss action may be moved into the intended operating range.

When a transmission line has a high SWR, its voltage and current relationship is no longer the same as with a low SWR. With SWR of 1.0, the line's impedance is determined entirely by its physical construction. When SWR is greater than 1, the line impedance may be either greater or less than its physical construction would indicate. The limits of variation are set by the SWR. For instance, a 52-ohm feedline operated at an SWR of 1 would always appear to be 52 ohms. At an SWR of 2, it could be anywhere between 26 and 104 ohms; when SWR rises to 5, impedance can range from 10.4 up to 260 ohms.

The lower limit of impedance is equal to the "normal" line impedance *divided by* the SWR. The upper limit is the "normal" line impedance *times* the SWR. Whenever the SWR is greater than 2, then, the actual feedline impedance a filter may be looking at is anybody's guess.

The points of maximum and minimum current are determined by the distance back toward the source from the discontinuity which is producing the standing wave. Every half-wavelength back from the discontinuity, the conditions at the discontinuity are duplicated. If, then, the discontinuity consists of an impedance *lower* than the feedline impedance, the *minimum* impedance will be present every half-wavelength back along the line. On the other hand, if the discontinuity is a *higher* impedance, then the maximum impedance will be present at half-wave intervals.

At the quarter-wavelength points which separate the half-wave positions, the *opposite* impedance condition exists. If a 75-ohm antenna is fed with 50-ohm line, this produces an SWR of 75/50 or 1.5. Every half-wavelength back from the antenna, the feedline will show 75 ohms (1.5 times 50 ohms) impedance. At quarter-wave points between these, the feedline impedance will be 33.3 ohms (50 ohms divided by 1.5).

At either of these points, whether maximum or minimum, the voltage and current are in phase with each other and the feedline represents a "pure resistance" load. Between these points, though, voltage and current are out of phase to a greater or lesser extent, and the feedline looks like either an inductor or a capacitor.

When a filter is involved, this can be disastrous, since the unintentional connection of an extra coil or capacitor into its tuned circuits may pull them completely out of adjustment. The result—excessively large power loss.

Even without filters in the act, the reactive impedance presented to a transmitter's output jack by a line with only moderate SWR can lead to surprising effects. For example, at certain critical line lengths an SWR as small as 1.3 can show an imped-

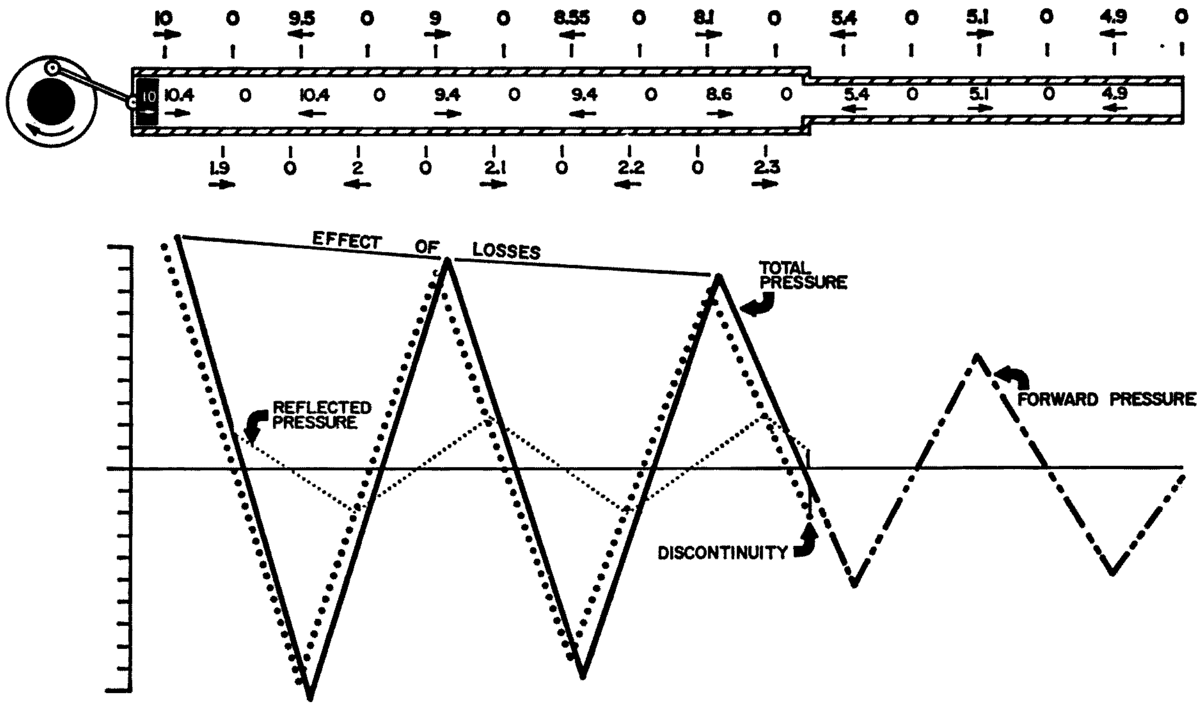


FIGURE 2—Losses in line cut back strength of reflected wave, thus reduce SWR.

ance which cannot be matched by most pi-network output circuits, although pi-nets are popularly supposed to be capable of matching anything! This particular condition comes about when the line looks like a large coil; the "coil" cancels out all of the pi-net output capacitance and there's nothing left to tune with. The cure is either of two things: get the SWR down still lower (preferred, but often impossible), or extend the feedline by an additional 1/8 wavelength to escape the critical area.

This effect of SWR is the reason so many antenna articles advise you to "prune" feedline length for best results. No installation can hope to maintain an SWR of 1.0 for any length of time; coax deterioriates, joints may corrode, and the antenna feedpoint impedance itself will change with the weather. Some SWR is always present. At critical line lengths it can produce startling effects. To avoid these, keep the feedline at multieples of 1/4 wavelength—or "prune" it for easiest transmitter adjustment.

We have seen how high SWR affects power loss, by increasing current density in the feedline. Surprisingly enough, power losses also affect the SWR despite many claims that the only factor affecting SWR is the impedance match.

Remember that the SWR is simply the ratio of peak to null voltage or current in a standing wave, and that the standing wave itself is due to interaction between a forward wave and a reflected wave.

At any point along a feedline, the forward wave is making its initial trip "up" the line. The reflected wave, however, has not only come this far from the source, but has also gone on out as far as the discontinuity, and then come back down the line that far again to get back!

For instance, if a feedline is 100 feet long, then at the transmitter output connector the forward wave has gone only a few inches (if that far) but the reflected wave has traveled 200 feet. At the midpoint of the line, the forward wave has gone 50 feet but the reflected wave has gone 150 feet—the same 50 feet traversed by the forward wave, plus the remaining 50 feet to the antenna, and then that last 50 feet back again in the opposite direction. And at the antenna, the forward wave has gone 100 feet but the reflected wave's journey is the same length.

If no line losses existed, it would make no difference where on the line you looked: the SWR would be the same everywhere.

But with line losses involved, the reflected wave gets weaker as it travels further. As the reflected wave weakens, the SWR be-

comes lower. It is quite possible to have an apparently perfect SWR at the transmitter end of a coaxial cable, and to have an infinite SWR at the other end of the line. In fact, serious VHF workers sometimes use several hundred feet of disconnected coax as a dummy load, since it has the best SWR available at UHF!

The effect is particularly noticeable with very high SWR, since the line losses are increased by the high SWR. The high line losses then cut back the reflected wave, reducing the SWR more rapidly than would otherwise be the case.

Fig. 2 shows how the effect works, using the same water-line and pump image with which we originally examined SWR in **Fig. 1.** Instead of a solid pipe, we're going to use a choked-down fire hose now. The fire hose is somewhat leaky, so that some of the pressure is lost along the way. This corresponds to the line losses we meet in a feedline. As in **Fig. 1,** the numbers are pounds of pressure and the arrows indicate direction.

Matching

How Can Lines and Antennas Be Matched? The cure to SWR problems is to "match" feedlines and antennas, so that any major discontinuities are removed and SWR remains low.

This can be accomplished in many ways. Rather than attempting to list in detail all of the ways in use, we'll refer you to any good antenna handbook for the gruesome details and here we will concentrate on the principles *behind* matching.

The whole idea of matching is to eliminate discontinuities in the path of the rf, and thus do away with the reflected wave which results in a high SWR. The simplest way to do it, whenever it may be practical, is to choose an antenna which is inherently matched to the feedline you intend to use; then you have no discontinuity in the first place. This solution, though simple, is not often practical, because antenna impedance varies with height, length, frequency, and even the weather. A perfect match one day may be a mismatch the next.

However, the simple half-wave dipole antenna and the folded dipole are both popular for "direct feed" use; the dipole is a fair match to either 52 or 75 ohm line while the folded dipole, as normally used, matches 300-ohm feedlines if operated at the proper height above ground.

Both these antennas, though, are "single-frequency" affairs insofar as perfect matching goes. If either is operated even slightly off its resonant frequency, it will show traces of either inductance or capacitance at the feedpoint—resulting in a discontinuity and resulting SWR.

So for normal use across a band, even these require some type of matching. For multi-band use matching is even more necessary, and the matching question becomes as important as the antenna design itself when beams and other directional antennas are involved.

Most matching networks operate indirectly; they eliminate the reflected wave from the feedline by giving it some place *else* to go. Thus the matching network itself usually has a rather high SWR; the feedline from transmitter to network, though, is essentially "flat" with SWR approaching 1.0.

An excellent example of this type of action is the "stub match" which is popular at VHF and finds some use at lower frequencies. This consists of a feedline section either shorted or open at the end (the "stub"), connected in parallel with the regular feedline at some place near the discontinuity. The stub deliberately introduces a *second* discontinuity, but the length and tap point of the stub are both chosen so that this second discontinuity cancels the effects of the first. The wave reflected from the first winds up harmlessly in the stub, and the feedline itself is free of standing waves.

One of the most popular matching devices is the "quarter wave transformer" which consists of a section of feedline 1/4 wave long, connected between the line and the antenna to be matched.

Remember that no matter what the SWR on a feedline, the feedline impedance will be resistive every quarter wavelength, and will alternate from minimum to maximum and back at these points. If a 150-ohm is connected to a 75-ohm antenna, it will have an SWR of 2 (line impedance divided by antenna impedance, or 150/75). Then 1/4 wavelength back from the antenna, it will have an impedance of 2 times 150, or 300 ohms.

Similarly, a 100-ohm line connected to a 300-ohm antenna has an SWR of 3, and 1/4 wave back from the antenna the line

impedance would be 100 divided by 3 or 33.33 ohms.

Therefore, a 1/4-section wave of transmission line can be used as an impedance transformer, to change the effective impedance of an antenna or a feedline to some new value. The new value is determined by the impedance of the 1/4-wave section; we could just as truthfully say that the impedance of the 1/4-wave section is determined by the transformation values needed, if we had some means of adjusting the built-in line impedance to any value we desired. If open-wire line is used, we have this means available, since its impedance is determined by the spacing between wires. For a 1/4-wave section, we can build our own to whatever spacing we happen to need.

The relationship of impedance in a 1/4-wave transformer section is: line/transformer = transformer/antenna. If both the line and antenna impedances are known and we need to find out what impedance we need in the transformer, we can rearrange this into:

6

$$\text{transformer} = \sqrt{\text{line} \times \text{antenna}}$$

For example, 50-ohm line and 70-ohm antenna give 3500, and the square root of 3500 is approximately 59.16. Since none of our values are accurate to 1% in ham radio, the closest-guess answer we would get by using 3600 instead of 3500, which is 60 ohms, would be close enough for all practical purposes.

The 60-ohm transformer section, connected to a 70-ohm antenna, would have upon it an SWR of 7/6. At the other end of the transformer the impedance would be 60 divided by 7/6, or 360/7 ohms. This comes out to 51.4 ohms, which would be a negligible discontinuity for a 50-ohm line.

If we left out the matching section, the SWR would be 7/5 or 1.2, with a 50-ohm line connected to the 70-ohm antenna. Use of the matching section has thus reduced the SWR to 51.4/50, or 1.028.

We've already looked at the means of measuring SWR. It's worth noting at this point that most SWR measuring devices are not sufficiently accurate to show you an SWR as small as 1.028; many of them won't indicate anything smaller than 1.05. Because of the effects of line loss in reducing apparent SWR, too, measurements aren't accurate unless they're taken as close to the antenna (or matching network) as you can get with the instruments.

DB

How Are DB Related to Power Loss? All along we've been talking about power loss; now it's time to look at the term most frequently employed to measure power gains and losses—the "decibel", which is abbreviated "dB".

It's named for Alexander Graham Bell, but the original unit turned out to be too large for convenient use and so the metric prefix "deci" meaning "one-tenth" was added to the basic "bel".

Like SWR, decibels measure a *ratio* rather than a *quantity*. This is what makes them so useful for gain and loss discussions.

Where we would have to multiply and divide, if we were working with the power-in/power-out ratio to measure power loss, the use of decibels lets us add and subtract instead.

Although the formula for calculating dB from the power ratio involves the use of log tables, you can be as accurate as is ever necessary if you just remember two pairs of numbers: a 3-dB power gain (or loss) means a 2-time change, while a 10-dB power gain (or loss) means a 10-time change.

That is, a feedline with 3 dB loss will lose half the power put into it, and deliver only the remaining half at the far end. The power put in is two times the power put out.

If the line has 10 dB loss, input must be 10 times output; to get any specific amount of power out, you must put in 10 times as much.

Working with these definitions you can determine the approximate power ratio for any other number of dB. For instance, a 7-dB loss is 3 dB less than 10 dB. Were it 10 dB, power out would be 1/10 of power in. Since it is 3 dB less than this, power out will be twice this, or 2 times 1/10, or 1/5 of power in. This means that 7 dB is a power ratio of 5 times.

To get the ratio corresponding to 4 dB we can first figure that for 7 dB and then multiply it by 2 again; the result is 2-1/2 times. Similarly, 1 dB is 1-1/4 times.

The exact formula, if you prefer to do things mathematically, for determining dB

$$\text{decibles} = 10 \times \log (\text{power}_1/\text{power}_2)$$

If $power_1$ is the larger of the two power figures, the dB will be positive and the result will represent a gain. If $power_1$ is smaller, the dB will come out negative and the result will represent loss. The easiest way to keep all the numbers straight is to define $power_1$ and $power_2$ so that the dB always come out positive (turning the ratio upside down if necessary to do this); if you have measured or calculated the power you already know whether gain or loss is involved, and you can then make the final figure either positive or negative as required—positive for gain, or negative for loss.

The fact that dB are expressed, by definition, in log terms is what permits us to add instead of multiply and subtract instead of divide. This, in turn, permits coax cables to be rated for loss in "dB per foot" or "dB per hundred feet"; we can find out the total rated loss of a feedline merely by multiplying its loss per foot in dB times the length in feet, and the result is the dB loss for the full line.

As an example, suppose a coax line is rated at 2.5 dB loss per 100 feet at 50 Mc (a not-unusual loss figure). If our coax is 200 feet long, we will have 5 dB loss in it even with a perfect antenna match and SWR of 1. If we now put in 10 watts from a transmitter, what will we get at the antenna?

From our 10-dB and 3-dB definitions, we know that we will get less than half, but more than 1/10, of the power through. Were the loss 6 dB, the ratio would be 4 (2 times 2). By taking 6 dB from 10 dB as we did earlier, we know that a 4-dB loss would be a ratio of 2-1/2. This means that our antenna will get less than 4 watts (10 divided by 2-1/2) but more than 2-1/2 watts (10 divided by 4). We may now either divide the 4 watts (4 dB loss result) by 1-1/4 (1 dB, from earlier example), or multiply the 2-1/2 watts by 1-1/4 (6 dB and 1 dB).

In the first case, we get 16/5 or 3.2 watts as the power delivered to the antenna. In the second, we get 25/8 or 3.125 watts for an answer. The variation is because there is a trace of inaccuracy in the definition of 3 dB (it's actually a ratio of 1.995 rather than 2) and when we apply it repeatedly, this inaccuracy begins to show up.

If we apply the formula directly, we find that the power delivered is 0.316228 times the power put in; with 10 watts in, the antenna receives 3.16228 watts. While neither of our non-formula answers was exactly correct, both were close enough for all practical applications. On the FCC exam it's most likely that the questions will deal only with 3, 6 or 10 dB figures; they're more interested in determining that you know what dB are and how to use them than in your ability to manipulate higher math!

All of our examination of decibels so far has been strictly in connection with *power* ratios. The decibel measures *only* a power ratio, but if a few rather strict rules are followed it's possible to express power in terms of voltage or current rather than directly in watts. The major rule is that both voltage or current readings must be made with reference to the *same* impedance level, and the minor one is that voltage can be compared only with voltage, and current only with current.

When this is done, decibels can be used to express the resulting "voltage" or "current" ratios. The definitions of dB then appear to change; actually, the definition stays the same but the way it's expressed changes. If you just remember that you're actually measuring *power* even when you're thinking *volts* it will help keep things straight.

For, you see, a change of either voltage or current in a circuit with its resistance fixed (the major rule) will change the other element, current, or voltage. And power is the product of voltage times current. If you double the voltage the current also doubles, and the power increases by four times. In any circuit to which you can legitimately apply dB for comparing voltage or current, the power will change as the *square* of either voltage or current.

A 2-time increase in voltage, then, produces a 4-time increase in power. And this 4-time increase in power is equal to 3 dB plus 3 dB, or 6 dB.

A 10-time increase in voltage produces a 100-time increase in power. This is 10 dB plus 10 dB (10×10), or 20 dB.

When the comparison is made using voltage or current measurements, the resulting dB figures must be multiplied by 2 to be accurate. Twice the voltage is 6 dB; 10 times the voltage is 20 dB. The formula becomes 20 times log (EI/E2) rather than 10 times log(P1/P2). But all in the world this is doing is converting your *voltage* measurement into a *power* figure, by automatically squaring the ratio!

It's sometimes convenient to speak of "voltage dB" or "power dB"; it hurts nothing to do so, so long as you remember that they're actually all the same decibels, and only the measurements differ.

Decibels apply to many things besides transmission lines—it just happens to be easier to see how they work here than anywhere else. Receiver noise figures in dB are a comparison of power ratio between the smallest discernible signal and the inherent receiver noise. Antenna gain is a power ratio between the antenna being measured and one which has no gain at all.

What Are the Advantages and Disadvantage of Using the Same Antenna for Receiving and Transmitting? Both transmitters and receivers require antennas; this means that we have the choice of either providing separate antennas for receiving and transmitting, or using the same antenna for both purposes.

Either choice has some advantages and disadvantages compared to the other; most operators have their own personal prejudices as well.

First off, *any* antenna which will transmit a signal well will receive that same signal well. This is the "law of reciprocity" and means that you'll pay no performance penalty by using the same antenna for both purposes. The advantages and disadvantages, then, must lie in other areas.

The comparison is complicated by the fact that there are antennas and other antennas. It's hard to compare, for instance, a half-wave dipole or a mobile whip with a quad-Yagi high-gain VHF beam array, or a UHF parabolic dish. Yet the choice between separate antennas, and single-antenna operation, must be made for all these types.

The major disadvantages of using the same antenna for both purposes are (1) it must be switched from receiver to transmitter and back again for every transmission, and (2) you can't listen while the transmitter is on. The first is usually overcome by an antenna relay or a T-R switch (electronic rather than mechanical relay), and the second isn't usually considered a disadvantage by very many folk.

The advantages of a single antenna are (1) any gain present in the antenna is there for both receiving and transmitting and (2) less space, material, and money is required to erect only one.

The first of these advantages is meaningless if your antenna has no gain in the first place, although it's important for the users of beams and other gain antennas. The second is influenced by the first—hanging up a second length of wire to install a separate dipole antenna is far less costly than erection of a second 60-foot parabolic dish complete with three-dimensional rotation!

For beginners, the advantages probably favor use of separate antennas. No switching is necessary, and the use of separate antennas permits on-the-air monitoring of the transmitted signal. Advanced workers, on the other hand, show strong tendencies to favor single-antenna installations with T-R or relay switching.

It used to be said that full break-in operation on CW required a separate receiving antenna. The advent of differential-keyed transmitter circuits and fast-acting T-R switches has sent this statement the way of the dodo bird; these days you can use the same antenna for transmitter and receiver, and still hear a breaking station between your own dits. Most of the other traditional arguments for and against separate antennas have gone the same route. The four facts listed above are just about all that remains—*except* for personal prejudices—upon which to make the choice or answer the examination question.

Next Round. We've looked at a little bit of everything in ham radio so far. Next month will mark the half-way point in this series, and one major area hasn't yet been touched. We'll get it then, when we examine receivers and how they work. ■

Letters

Intruders

Dear Kayla,

It is a well known fact that no dummy load can duplicate exactly the electrical characteristics of a real antenna. It is also known that tuning up one's xmitter on the air is poor operating procedure at best, and a source of QRM at worst.

I have adopted the following procedure: I find a propaganda station, tune to their precise frequency in the ham band in which they are intruding, and load the Xmtr on their exact frequency. I can cause no addition to the QRM they are causing, and I would take delight in knowing that I caused their SWL listeners some difficulties in reception. I intend to continue this practice in the hopes of causing them some discomfiture.

Your suggestion that SSB transmissions a few cycles away would help drive them out is a good one. If I ever go SSB, I'll be happy to help out. In the meantime, I'll continue to load my antenna on a zero-beat with their frequency. Yours for more QRM for the intruders.

Herbert J. Dnnkerley WA3JIX
Jeannette, Pa.

Zero-beat won't do it. Set up a howl 50 Hz off zero-beat and you might have a good plan.

Dear Kayla,

Hurray, and a tip of this OM's hat to you! Re your editorial in the May issue, I've finally heard someone speak out on these 40 meter Broadcasters; it took a woman to do it . . . alas!!

I've personally heard the BBC QRM. Really nice chaps!! We had better start fighting fire with fire before we lose the frequencies to these intruders. Better late than never??

Bill De Lage WA1HAA
Esmond, Rhode Island

Dear Kayla,

Your May 1968 editorial was on target. Positive action must be taken to combat the foreign broadcasting on 40 meters. Here is my proposal:

Allow unlimited amateur power between 7100 kHz and 7300 kHz from 6:00 PM local time to 6.00 AM, local time.

There are a number of American hams who have the wherewithall and initiative to run super-power (that is for hams) and utilize beam antennas to enhance their signals even more. I say, let us allow this regulation. I'm sure it would result in a re-evaluation by broadcasting interests of programming in the 40 meter band.

One final word. While it is "legal," the Voice of American broadcasts appearing in the region 2 40 meter ham band (and on 80 meters also) are not consistent with our government in respecting their own U.S. amateur radio frequencies.

James A. Gundry W8BW
Dearborn, Michigan

I don't think we should allow UNLIMITED power! Maybe we should limit it to 50 KW?

Dear 73,

W1EMV's April editorial on incentive licensing is well written. Concerning that poor soul who was making \$200 per week, suddenly being cut to \$150; then trying to find reason to work even harder to get back to his previous status: It isn't difficult to figure out what his next move will be.

This same idea could be appplied to commercial amateur equipment whose 100% *use* value and actual cost is \$200, for example. However, with incentive licensing, we have the situation where the use value is suddenly cut to something less than 100%, but the cost is still \$200. Upon purchase of gear, you may not be able to utilize it fully unless you have, or acquire, a certain amateur license. This takes away the "incentive" to buy.

. . . for most of us, incentive licensing means hack to the books. This is great as we will contribute something to the betterment of amateur radio (we think), but we certainly won't be rewarded by a much needed raise in pay from the boss upon passing that next higher amateur license.

Earle B. Foote K1BTF
Framingham, Massachusetts

Article Comments

Dear 73,

In conjunction with the timely article, "Are Phone Patches Legal?" by Ken Sessions, K6MVH in the May issue of *73*, I call attention to the last sentence in his paragraph II: Instead of a "—threat to their overall income" of the telephone company, the amateurs' phone patches are directly responsible for probably tens of thousands of dollars in additional income.

I am an Airforce MARS phone traffic net member, and our WESCOMMRGN alone handles thousands of phone patches each month from South East Asia, let alone other MARS nets in the Mid-West and East doing likewise from European installations of the U.S. Government.

This service is free to our service men, but, when the calls come through to Stateside, I would say without fear of contradiction, that the majority of them are put through on a collect basis and the folks "back home" accept the charges.

It goes without saying that were it not for the phone patches, these telephone calls would not be made over these great distances as the cost would be prohibitive.

Unquestionably the telephone company is well aware of this. They would have to be awfully dumb not to, and they are not dumb, but I assume they feel they would lose face to admit it, or they, on the otherhand, will not acknowledge to the amateur his just dues.

R. C. Kyle K6GRP
Kelsey, California

Dear 73,

A few comments on the IC Keyer in March '67 *73* page 50. It works fine business, but there is an error in the schematic. The SN7032 flip-flop has only 14 leads. The lead marked 15 in the diagram should read 5. C4 may also be low in value; if the dash flip-flop won't work, increasing C4 to 100 mmF may help. The unit I built needed about 100 mmF at C4 to trigger the clock pulse of the dash generator. Again, the keyer works FB and congratulations to W5FQA for a good keyer and construction project.

Tony Surnda WB3JXE
Baltimore, Md.

Dear 73,

Recently I completed my version of the Kleiner Keyer. I am very satisfied with the job this unit is doing. This is the first time I've used a transistor for keying grid block bias. I have built two other keyers previously, using plate circuit and mercury wetted relays, but they can't compare with the clean and crisp keying I'm getting from the Kleiner Keyer. Many thanks to W4UHN/WB2PKE.

Gent C. Lam WA1CQF
Springfield, Mass.

Dear OM's,

As a founder and member of the International Amateur Radio Club and Administrative Officer of the ITU in Geneva, I read the W2NSD editorial in the March 73 about our frequencies with interest. Nobody can say if we will lose our bands in the future, but we all must take care not to put amateur radio under a cloud by using illegal call signs. Rather we should work on the positive side and improve our image.

On February 24th I found myself involved in a story which made the papers in most of Europe and which should increase our reputation. I picked up an SOS message from Poland asking for a rare drug to keep a four year old child alive. The child would die unless the drug could be rushed to Nowa Sol within 24 hours.

Within the 24 hour period the Geneva hospital pharmacists were called back from weekend leave, three doses of the medicine were prepared, the Red Cross and airline officials arranged customs clearance and the medicine was flown to Paris and then on to Poland. I have a letter from the boy's father letting me know that the boy's life was saved!

Fernand Dubret HB9PJ

UFOs

Dear Wayne,

That "Flying Saucer" in the May issue. Take a REAL CLOSE LOOK. I can detect a very fine thread line from the center of this old hat upward to the upper end of the photo.

Jim W8BU
Cleveland, Ohio

The original Polaroid picture was greatly enlarged and examined very carefully for any possible tricks, sharpness of focus of the UFO in comparison to the foreground and backgrounds, etc. The estimate of the experts was that the photo was authentic. The original has since been borrowed by the government and "lost."

Dear Mr. Green,

I would like to commend you on your superb suggestion for the establishing of a UFO communications network spearheaded by amateur radio operators. While I am not a ham operator myself, several members of the Louisville UFO Investigations Committee are. The Committee as a whole is quite excited about your proposal.

I am writing to suggest to you that Louisville, Ky., be designated one of the "control stations" for the network. Louisville's qualifications are many. It is located near the population center of the United States, and despite being situated in the Ohio Valley, weather conditions are generally adequate for proper communications. Louisville is also located in an area of rather frequent UFO sightings. One of our Committee members already possesses a station with equipment enabling him to be heard across the nation with relative ease. And the Louisville and Jefferson County police departments, Civil Defense, aviation authorities and news media are already familiar with the Committee and its operations. We would be more than happy to take the necessary steps to establish a net control center here in Louisville.

Perhaps I had better tell you a little more about the Committee. The Louisville UFO Investigations Committee is a group of business and newsmen in Louisville and Lexington, Ky. dedicated to the scientific study of the phenomena. Our members include three newspaper writers, two electronics engineers, a flying service owner, medical student and a chemical engineer, just to name a few. No doubt your office is being flooded with letters of this type. But I hope to impress upon you the sincerity and *ability* of our organization to be of help in the functioning of the network.

You have made the need for such a communications network very evident. Your contribution to the study of the UFO problem will be a great one if the network

in fact comes about. Our hearts, minds, bodies and wallets if necessary are with you one-hundred per cent. Please let us know exactly what contribution we may be able to make. The time has come for action—and we are both ready and willing to act.

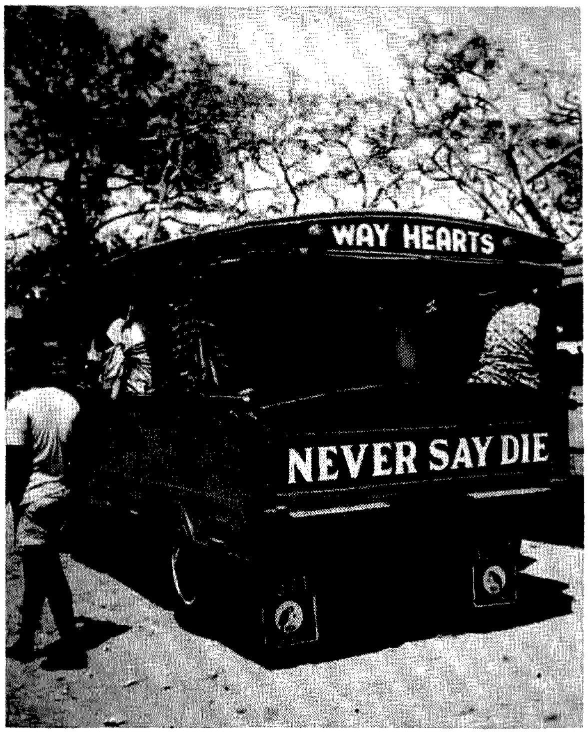
Glenn O. Rutherford
Chairman
Louisville UFO Investigations Committee

Good to hear from you. Louisville might be just fine for a control center. Schedules are for 0100 GMT on 14,300 Wednesdays and 3900 on Thursdays, same time.

Dear Wayne,

This photo was taken in Ghana. The vehicle is called a "Mammy Bus." The photo brought down the house at the DX Convention in Fresno this year.

Lloyd & Iris Colvin
W6KG—W6DOD



Dear 73,

I have become very interested in the 900 young men at Boys Town, Nebraska, and their amateur radio station WAØOGI. I have been helping the boys there to work DX and have enjoyed it very much.

They have had a hard time getting out due to a very poor antenna installation and location. It is only up 20 ft. and just 4 feet off a metal roof. In a westerly direction, the antenna faces the side of the 70' field house which is also metal.

The board members refuse to allow the antenna to be put up on top of the field house, or to allow a guyed tower or telephone pole, but would permit a self standing tower to be erected.

Since Boys Town is supported purely by voluntary contributions, the income does not permit such an expense. I am willing to make a $5.00 contribution to such a project and wonder if other amateurs would feel the same way. If they would forward ideas and/or help to me, I will do all in my power to see that Boys Town has the best club station possible.

Marty O'Hara WAØRWW
36 Pine St.
Millard, Nebraska 68137

Dear Wayne,

How about running an Employment page for Communications and Electronics type people. Large companies spend plenty to send recruiters around the country. They are looking for top notch men, as a rule, and the reject rate of applicants tested runs as high as 97 percent, I am told. I know what I'm talking about because I have been "recruited" several times for various projects. Maybe you could solicit some recruitment advertising at attractive rates, since this would also be a reader service. Some companys who might be interested are: Federal Electric Corp., Paramus, N.J., RCA Service Company at Cherry Hill, N.J. and Page Communications Engineers at 3300 Whitehaven Street in Washington, D.C.

Point number two is this: What gives with Radio and Electric Industry as a way to make a living. I have been in this sorry business for twenty years and the only time the pay has been anywhere near what a plumber makes, is when the job was overseas. Here in Michigan, Electricians make 5.37 an hour for little more than pulling wire, and threading conduit and in the same town I have found Radio Stations offering $80 a week for a man with a First Phone license. If you ever quit the magazine business how about starting a *good* union, something like the Airline Pilots have? I would like to see if there is any reader reaction to this idea.

Harvey Heinz
Gladwin, Michigan

(The job column is an excellent idea, though I might take the first good one that came along. And on the union idea . . . all we need is a union that is run by the same guy that botches up 73 every month. Wayne.)

Help Schools and Libraries

How would you like to have an impact on your own neighborhood all out of proportion to the effort it will take? Why not see that copies of 73 yet into your local town library so that teenagers will have a better chance to get exposed to amateur radio? Here's your chance to get kids in your area interested in ham radio at the best time of their lives. You'll be doing ham radio a great benefit, your neighborhood a benefit, the kids a benefit . . . and even helping our country by encouraging more kids to pursue an interest in a technical hobby which can and usually does lead to work in electronics.

Just send in subscriptions today for your local library and high school library and we'll start their subscription and inform them that it is a gift from you.

Third Party Traffic Notice

This is to advise that United States amateur stations and amateur stations of U.S. Armed Forces personnel in West Berlin may exchange third party communications. Such West Berlin stations are identified by call signs DL4Q. . and DL5Q. . Third party communications with amateur stations in other parts of Germany is *not* authorized.

Code Practice Stations

In England there are several dozen stations participating in sending code practice. Perhaps we are a bit behind in the U.S. due to our dependence on W1AW for our code. They do a nice job of it, doubtless, but they are hard to copy in much of the country and sometimes it is difficult to fit your schedule to theirs.

If any of our readers are sending code practice on a regular schedule and wish to make their service known we will be glad to list your schedules in 73. Please send in the times, days of the week, speeds, and frequencies for our listing.

I would suggest that automatic tape sending equipment is a must for such a service. Dependability is another must.

Now that all of the DX'ers are working for their Extra Class License there will be a demand for twenty words per minute code as well as the 13 wpm. There will probably be a great demand along about November when the first slice comes off the meaty end of the DX bands.

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

GONSET 6 METER 200 Watt Linear and h.b. exciter $90. Telrex 11 element 6m spiralray $85. Topaz transistorized 300 watt p.s. C10WDG $50. Clegg Thor VI w/a.c. p.s./mod. $169. Motorola 30D on 6 A.M. w/transistorized modulator $35. Gonset #3012 (152-162 M.C.), #3011 (40-50 M.C.) tuners @ $35. All F.O.B. Richard M. Jacobs, WAØAIY, 4941 Tracy, Kansas City, Missouri 64110.

BACK ISSUES WANTED. I am the agent for "73" in Scandinavia. Many people want reprints of articles in copies no longer available. Can you help?? Need Jan., Feb., 61; Jul., 66. Your price paid if reasonable. Write to: Eskil Persson, SM5CJP, Frotunagrand 1,19400 Upplands Vasby, Sweden.

MECHANICAL ELECTRONIC DEVICES CATALOG 10¢ . . . Teletype Model 14 reperforator with automatic tape take up rewinder 115VAC 60cy. Both units new, unused $69.95 . . . ARR27 Receiver 29 tubes 465-510 MHz w/60 MHz if new, unused $35 . . . 1/16 laminated copper clad 2 oz. 2 sides, for printed circuits 9½x4½ $1 . . . 3/$2. Transistor boards bonzana $5.95 . . . Wide band balanced modulator $4.95 . . . 30 MHz IF Assembly $5.95 . . . Transmitter TDG w/Modulator easily converted to 2 meters $49.95 . . . Low pass filter 0-32 MHz 52 ohm $9.95 . . . 5KV/2KV/1KV at 750 ma/200ma/250ma Power supply write for details. Fertik's, 5249 'D", Phila., Pa. 19120.

"SAROC" FOURTH ANNUAL FUN CONVENTION scheduled January 8-12, 1969 in Hotel Sahara's new space convention center, Las Vegas, Nevada. Advanced registration closes January 1, 1969. Ladies program in Don The Beachcomber. Technical seminars, FM, MARS, RTTY, QCWA, WCARS-7255. Registration $12 per person entitles 'SAROC" participant to special room rate $10 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Saraha's late show, Sunday breakfast equal to any banquet dinner, ask any 'SAROC" veteran. Brochure planned November mailing for details QSP QSL card with ZIP Southern Nevada ARC, Box 73, Boulder City, Nevada 89005.

VIKING RANGER F.W. $110. 250 QST's HO CQ Magazines $35. A. Urquhart, 198-26 Epsom Course, Hollis, N.Y. 11423.

GSB-2 GONSET SIDEWINDER, good condx, $190. Trade for late SBE-33. New 911A AC PS $40. DL5QN, Box 448, Co. A, USASAFSBERLIN, APO NY 09742.

THE QUAD CITY AMATEUR RADIO CLUB has scheduled its annual Mississippi Valley Hamfest for August 18, 1968 at the Rock Island Arsenal, Rock Island, Illinois. The site this year is an all-weather site with adequate display facilities. Lunch will be served in the cafeteria. Price for tickets is $1.50. Contact John E. Greve, W9DGV, 2210-30 St Rock Island, Ill 61201 for advanced tickets. Frequencies to be monitored are 3900 50.4 and 146.94 mc.

SWEEP GENERATOR, Philco model G8002, 470-890 MC ±1DB, Sweep width 0-50 MC, new condition in factory carton. Cost $289.50, Sell $50.00. W4JGO, R #2, Box 149, Salem, Virginia 24153.

HAMMARLUND HQ-180 AC, excellent cond, 4 yrs old, with noise immunizer, S-200 speaker, $285. Write—Walt Snyder, Apt. 4, 916 Shippan Ave., Stamford, Conn. Call days—212-HA2-4800, x 755.

R-388-51J3 BFO, transformer wanted (500kc) Will pay cash or trade. WA2ULP Donald Van Dorn, 7 Layman St., Ravena, N.Y. 12143.

COLLINS—SELL R388 (51J3) $425, R390-A $750. R391 $800. All new condition factory aligned. Dumont 403R Scope $200. Box 781, '73", Peterborough, N.H. 03458.

CANADIANS: Wanted VHF FM Rcvr. 130-150 mhz for satellite APT reception experiments. Power supply and fancies not essential. Advise your item. A. Lacell, VE4LR, Box 95, Ft. Churchill, Manitoba.

SONY VIDEOCORDER TV tape recorder, 9" monitor, camera and accessories. Cost $1400. New—$900 sacrifice. Guaranteed perfect. K9EID Bob Heil, Marissa, Ill. 62251.

IBM CABINET & RACKS, idea for operating position or super rig. Steel desk console 57"w, 47"d, 66"h., 2 racks 21"w, 82"h, one full of plug-in units, tubes, components; other with door. Make offer. K6BCS, (213)886-0111.

CANADIANS: FOR SALE EICO 754 & 751. Transceiver and power supply. Best offer. Write VE7KC, 89 Corry Place, Penticton, British Columbia, Canada.

SACRIFICE. Must sell all my teletype equip. Model 15 $45.00. Model 19 $75.00. TD $25.00. Reperf. $20.00. Make offer on all. Will trade. K6OBH 2253, Kelton, L.A., Calif.

432MC CONVERTER. Convert to 7-30MC. Removed from missile guidance system, size 2"x3"x 3½", 2 tubes-2 diodes, complete with schematic & instructions less crystal. Unused $14.95 each. Also 100V PIV, 1.5A Epoxy diodes, 45¢ each, 10 for $3.99. Tubes 6146A, unused, $1.00 each. We pay postage on prepaid orders. Alpha-Tronics, Dept. A, 14251 East Colfax, Aurora, Colo. 80010.

SELLING OUT. Any reasonable offer will be accepted. AF-68, PMR-8, M-1070 Elmac, VHF-1 Seneca, 621 Amplidyne Transmitter, HW-30 tower, HE-80 receiver, HQ110A, 425 Eico, 950B Eico, 710 Eico, 260 Simpson, TG34 Keyer, RBC receiver, misc. converters, Citation IV pre-amp. and more. Irv Better, 2500 Channing Rd., Cleveland, Ohio.

THE WABASH VALLEY ARA will hold its twentieth annual VHF Picnic on Sunday, July 28, at Turkey Run State Park, about 40 miles north of Terre Haute, one mile off U.S. Route 41 and on Ind. Route 47. One dollar ($1) registration charge at gate only. Swap tables, eye-ball QSO's, entertainment for the ladies and mobile check-in on 52.525 M.C.

TRADE—NORELCO STEREO Continental "400" three-speed stereophonic tape recorder Model EL-3536A/54. Want 2 meter FM gear, good camera, or what have you? K9MWA, 609 Henrietta St., Gillespie, Ill., 62033.

THE KNIGHT RAIDERS VHF Club will hold its Second Annual Hamfest on Saturday, July 20, 1968 at Weasel Drift Picnic Grove, Garret Mt. Reservation, West Patterson, N.J. from 10 am until dark. The location is the same as last year. Manufacturers displays, swap shop, junque tables, contests, door prizes, and a good time for all will be the order of the day. Picnic tables and barbeque pits available. No tickets, no fee, it's free. Refreshments will be available. Talk in station K2DEL/2 will operate on 50.4 MC and 146.898 MC. Special certificate for contacting the talk in station available. For more details write K2DEL.

SELL: HQ-100-C w/speaker, Eico 720, 730, 722. Mike, SWR, low-pass, VOM, pre amp, extras. $175 FOB. Stephen Clifton WA2TYF, 800 West End Avenue, New York, N.Y. 10025.

PACKAGE—NCX-200 + NCX-A AC/speaker console. Factory sealed and guaranteed. $410 postpaid. Kight Electronics, Box 998, Abilene, Texas 79604.

AMATEUR RADIO AND YOUR CALL on 7" x 4" reflective Scotchlite decal, 1½" letters. $1.75. Will last years. Stan's Signs—W7CRG, 618 Beth Drive, Great Falls, Montana 59401.

BEAUTIFUL GOLD BORDERED CERTIFICATE that no ham station should be without. Answers questions that visitors may ask. Yours for a donation of fifty cents in coin to: The Rockaway Amateur Radio Club, Post Office Box 205, Rockaway Park, New York 11694.

CANADIAN: For sale—ARN7 receivers in clean condition. $14.95 F.O.B. Edmonton. Allow for 50 lbs. freight and $1.00 crating charges. T. M. Brynko, 8319 101 Ave., Edmonton, Alta., Canada.

DISCOUNT PRICES—TIME PAYMENTS. New equipment, factory sealed cartons, full warranty. Drake R-4B $379. T-4XB $379. L-4B $599. TR-4 $511. Galaxy V Mark III $369. National NCX-200 $315. NCL-2000 $595. SBE-34 $380. All new factory sealed cartons, no down payment with approved credit. New CDR Ham-M & Indicator $99.95, TR-44 $59.95. All equipment in stock—immediate delivery. Mosley TA-33 (Reg. $120.99) Discount Price $99.95. New Triex W-51 self supporting tower (Reg. $362) $299.95 prepaid. Reconditioned specials—Swan SW-500C $399. SW-350C $319. SW-250 $239. Time payments on any purchase. Send for free catalogue. Edwards Electronics, 1314—19th St., Lubbock, Texas, 806-762-8759.

SELL: Immaculate SB-34 transceiver with mike, $300. Eico electronic keyer, new, $45. Hallicrafters SX-42 and R42 speaker, aligned and reconditioned, $150 or make offer. KWS-1 serial, #1465, $800. Knight RF 'Z' bridge impedance device, $10. Turner 80X microphone, $5. Eldico SSB-100F aligned and reconditioned, $275. Spare 5894/AX9903, good, $4. Lee Richmond, 166 Floral Ave., Plainview, N.Y. 11803, DE 3-8663.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB P. Wandelt, RD # 1, Unadilla, New York 13849.

WRL'S USED GEAR has trial-terms-guarantee! Gonset GSB6-$189.95; HW 12-$89.95; Galaxy V-$269.95; SR46-$99.95; AF67-$49.95; Valiant-$149.95; Viking II-$79.95; 600L Linear-$179.95; HQ100-$99.95; 75A1-$169.95; RX1-$149.95; RME 4300-$79.95. Hundreds more—low prices. Free "Blue-Book" list. WRL, Box 919, Council Bluffs, Iowa, 51501.

INTEGRATED CIRCUIT PROJECTS. Audio amplifier, signal tracer, code practice osc., two-tone test osc., audio generator, sensitive f.s. meter, square wave generator, etc. Catalog, 25¢. Plans $1.00 each. Catalog free with order. One IC and printed circuit board builds all. $5. Hals Electronics, P.O. Box 137, Milpitas, Calif. 95035.

THE TRI-STATE AMATEUR RADIO SOCIETY'S Twenty-first Annual Hamfest will be July 21 at The 4H Center on North 41 Highway near Evansville, Indiana. Large air conditioned auditorium, Ladies Bingo, Swapper's row, over-night camping, fun and games for all the family. Advance registration $1.50 ($2.00 at the door). For details contact K9LAU Jack Young, P.O. Box 492, Evansville, Ind.

CERTIFICATE AVAILABLE. 1968 is Centennial year for Ogdensburg, New York. Contact two members of the Ogdensburg Amateur Radio Club and send for certificate to Lois Ierlan, 725 Proctor, Ogdensburg, N.Y. 13669.

THE ESSEX COUNTY V.H.F. SOCIETY will award an annual trophy to the highest VHF/UHF Field Day score in North America, from completed logs submitted to the Society, postmarked no later than July 31st, 1968. A.R.R.L. rules apply in all respects as applicable. Mailing address: Essex County VHF Society, Box 1137, Essex, Ontario, Canada.

LOUISVILLE HAM KENVENTION, Saturday, August 31 at the Executive Inn, featuring Dealers and Manufacturers; Technical Forums; Contests; Fashions for the Ladies. 648 South Fourth Street 40202.

THE AMATEUR RADIO COUNCIL OF ARIZONA will sponsor a Hamfest in Flagstaff, Arizona on July 26-28. The Hamfest will be held at Fort Tuthill in Coconino County Fairgrounds. Included will be games of skill, contests, swap table, auction, and a Pot Luck dinner on Sunday. Free sites for camping, campers and trailers are provided at the Fairgrounds with rest room facilities available. Motel accommodations are available in Flagstaff, just north of the Fairgrounds. All amateurs, families, friends and would-be amateurs in the state are welcome, as are any amateurs passing through. There will be talk in stations for mobiles on 3878 KHZ and 50.34 MHZ. For further information write Amateur Radio Council of Arizona, P.O. Box 6602, Phoenix, Arizona 95005.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

NOVICE OR OLD-TIMER. PLANS: 4 band 50-watt cw XMTR. XTAL or VFO, inexpensive to build, good, $2.00. Bert Dawson, 304 Third St., Eau Claire, Wisc. 54701.

SWAP: BC221 frequency meter, original calibration book, excellent condition, for Heath HP23 A.C. power supply. John Orange, 24 Lincoln Av., Jeannette, Pa. 15644 W3ZDF.

TWENTY-METER ANTENNA SYSTEM. Vesto HPX-100 tower, Telrex 20M-546 beam and A2675RIS rotor. $1800. FOB Alamogordo. Write for details. W5OPL, 710 Arnold, Alamogordo, N. Mex. 88310.

PRINTED CIRCUIT BOARD—single or double sided 9x12—75¢; 6x9—40¢; 4½x6—20¢; 3x4½—15¢. Minimum order $1.00—no. C.O.D. Star Sales Company, 404 West 38, Wilmington, Delaware 19802.

ANNUAL UPPER PENNINSULA of Michigan Hamfest to be held in Sault Ste. Marie, Michigan, August 3 and 4, Saturday and Sunday. There will be a banquet on Saturday evening complete with the usual "Afterglow." Twin Sault Radio Club, Box 279, Sault Ste. Marie, Mich., 49783.

MUSKEGON AREA AMATEUR RADIO COUNCIL (MAARC), will offer a special QSL card to commemorate Muskegon, Michigan's Annual Seaway Festival 6/30-7/5. This special QSL will be available from Muskegon amateur radio stations contacted from June 24 through July 5. All bands and modes will be used including RTTL and novice participation. These contacts will also make stations eligible for the coveted 'Muskegon County Award" (Mich. stations work 15, U.S. work 5, and foreign stations work 2). For the County Award, log data only should be sent to P.O. Box 691, Muskegon, Mich.

THE MT. AIRY V.H.F. RADIO CLUB is holding its 13th Annual Family Day and Picnic on Sunday, August 11 (rain date August 18) at Fort Washington State Park, Flourtown, Pa., in cooperation with the Delaware Valley Chapter of the QCWA. Come and get together with your families and friends for an old time outing of games, cook-out and just plain relaxing for a day away from home. There will be games for the kids and activities for the YL's and XYL's. Free soda for all. No reservations required. $2.00 per family.

NATIONAL INCENTIVE LICENSING POLL RESULTS—639 against and 178 for. Our ads were in the three leading ham magazines. WB2NOD, Box 685, Moravia, N.Y. 13118.

FOR SALE. 75A4, Serial 4190, .5, 2.1, 3.1 filters with SB610—$475. HT-37, 3 xtals full 10 mtr coverage—$250. B&W L1000A linear with input tuned ckts—$175. HX-20, HR20, HP20, HP10 plus mobile mike—$250. Joseph Soroka, Jr. W3LGD, P.O. Box 88, Irwin, Penna. 15642.

CONVERTER SALE three transistor, 50-54 MHz input, 14-18 MHz output, wired, tested printed circuit. Crystal controlled, $6 ppd. Adjustable, $5 ppd. Syntelex, 39 Lucille, Dumont, N.J. 07628.

TRADE Auto-Rollieflex Camera with eveready case, Rolleikin 35mm adaptor, exposure meter and other supplies for a good receiver. John E. Bagwell, Somerville, Tenn. 38068.

KNOB, for Collins 75-A receiver, 6 to 1 reduction. $7.00 postpaid. Jules Wenglare W6YO, 1416 7th Ave., Delano, Cal. 93215.

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AUGUST 1968

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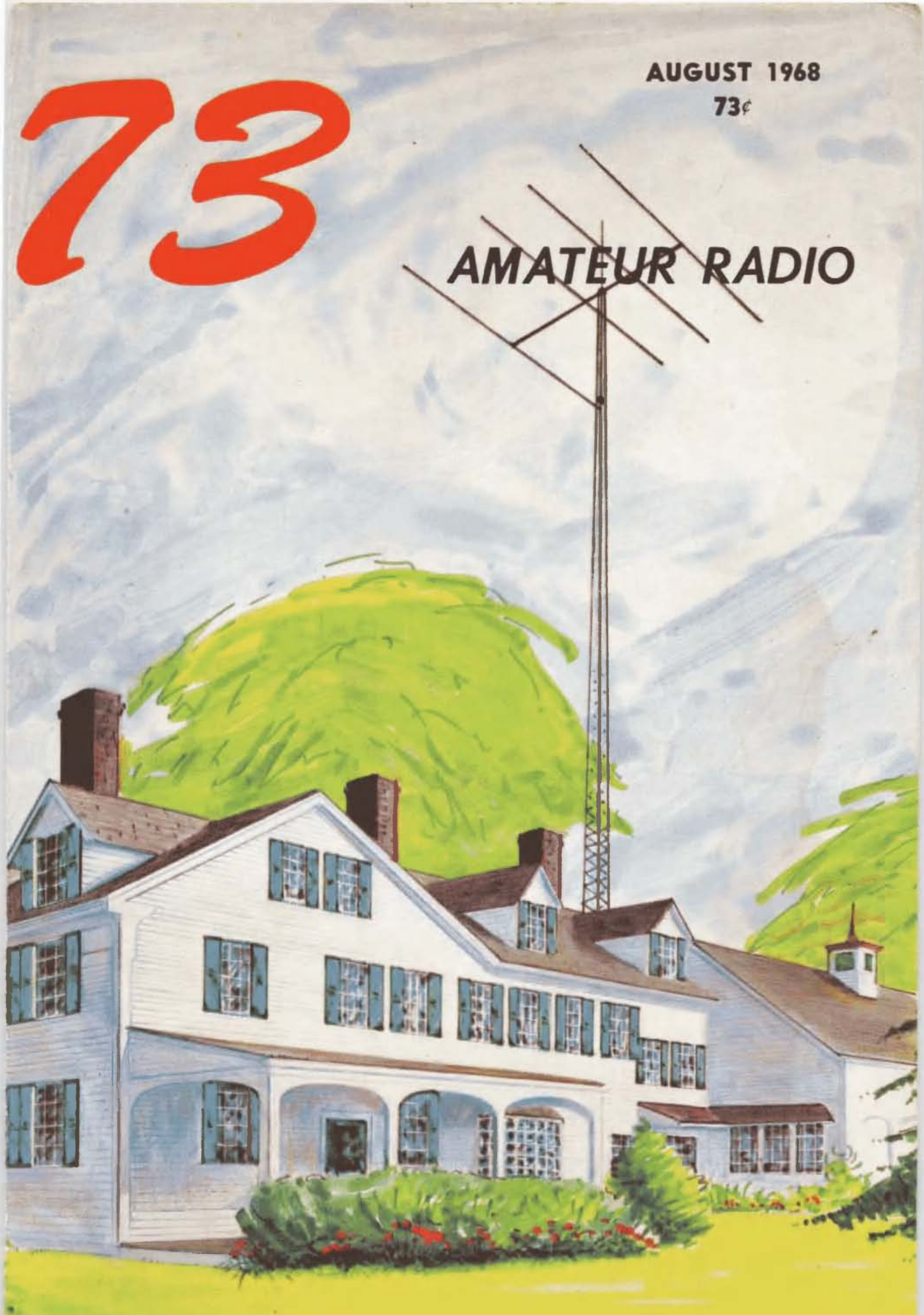
AMATEUR RADIO



73 MAGAZINE

August 1968
Vol. XLVII No. 8

Departments

Cover: An original painting by Sydney Willis. This is the house where 73 Magazine is produced. The house is over 200 years old and contains some 37 rooms.

Wayne Green W2NSD/1
Publisher

Kayla Bloom W1EMV
Editor

73 Magazine is published monthly by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S.A. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.
Stop reading this fine print. Look at page 66 and go out and sell subscriptions.

Editorial Liberties

There are some days in the life of this editor when she wonders where she can obtain a good cyanide pill to end the agony. There is a goof on page 101 of the June issue. A close look at the diagram will show that this circuit can't possibly work. The coil is shorted out. Our draftsman is usually on the ball and doesn't draw errors into a diagram, so I sent it off to have an engraving made. When the proof of the engraving was returned, the error was obvious, so I very carefully took the original drafting and used white correction fluid to block out the line which shorted the coil. I returned the proof of the cut with the error and told the printer to kill it and insert the new one. The new proof came back all ok, and I heaved a sigh of relief that I had caught the error. Then the magazine came out in print . . . How can you win?

The first few months of my editor's job were pretty hectic. I didn't have much experience in production and was thrown into the work to sink or swim. The files were full of articles, but no drafting was done. It is hard to print a construction article unless you have diagrams to illustrate it. The time lag was severe! Our draftsman was involved in moving and his equipment was packed up. A search for someone to do the work proved futile. So . . . we had three months of having to fill the pages with articles which didn't require much artwork.

There were many complaints from irate readers who impolitely told me to get back to the kitchen where I belonged. But, cooking for one isn't terribly rewarding, so I answered the letters as politely as I could and muddled onward. I kept muttering to myself, "keep the faith, baby" and sure enough, things began to work smoothly again. The flow of material between the magazine and the draftsman began to move, and a few letters of apology came in.

To those who encouraged me, my thanks. To those who were disgruntled and angry, I hope the last couple of issues have improved their state of mind.

We hams frequently handle emergency traffic and usually come through with flying colors. It is a natural thing to wish to give credit by notifying the news media so there will be a write-up in the newspapers or perhaps radio and TV coverage. In some instances, in order to properly impress the public with our good work, the facts get distorted and the emergency becomes exaggerated.

Quite recently, Alan Biggs W3ZP was sailing his new 46 foot Catamaran from Yucatan, Mexico, to Key West, Florida enroute to Chesapeake Bay. On the second night out, one compartment flooded due to a back up of the sea cocks leading to the shower. This flooded the 32V batteries, so there were no lights. Alan hooked up the 40 meter rig to the starting batteries and made contact with Bob Fenimore W4TY in St. Petersburg. Bob notified the Coast Guard and aid was sent. They were taken under tow by a shrimp boat which began towing at a fast clip. This caused further damage to Alan's boat. Both rudders snapped off before he could contact the shrimp boat to slow down. Other than being exhausted from bailing, at no time was the boat or it's four crew members in any serious trouble.

The stories which reached the newspapers from hams told a very different tale. They told of the boat in danger of sinking, that both engines were flooded out, that they were in high seas and had no power. In fact, at no time did the engines quit as they were in watertight compartments. While one compartment of one hull was flooded, they were able to keep up with the bailing and the second hull had no water at all. Most of the damage was caused after they were safely under tow and headed for Key West.

It seems to me that accurate reporting of facts without embellishment will do ham radio more good than blowing up a minor incident into an "emergency" situation. Most of the stories which were on the ham bands involved second and third hand information. I am reminded of a game we used to play when I was a kid. It was called "telephone" and a whole group of kids would form a

Turn to page 90

de W2NSD/1

UFO Net Report

More and more UFO investigative groups have been getting the word about the amateur radio UFO net and have been writing to find out about amateur radio activity in their vicinity which might tie in with their work. We certainly have struck a spark at the right time with this activity.

The first announcement of an actual net frequency and time was made last month and even before the June issue was out there were seven stations calling in for the first net meeting. By the second week there were over 50 checking in. We will continue to meet on Wednesday nights for net check in on 14,300 kHz at 0200 GMT. If the interest in the net continues the way it has we will soon be able to have a check in every evening of the week at that time . . . and may eventually work toward our goal of getting upward of a thousand stations tuned to the alerting frequency with a simple automatic alarm.

If you are interested in joining this net all you have to do is check in on Wednesday nights and start getting ready for handling emergency traffic. Contact your local newspaper and radio station and tell them the story of the purpose of the network and get them to release information to your area so that you will be immediately informed if anything is sighted that should be reported. Contact your local police and CD officials too. If there is an active CB group contact them. Contact any other users of mobile radio in your area. Contact the highway department, doctors, taxis, any users of mobile radio and offer to alert them if they will in turn alert you when something is sighted. Point out that this effort is not restricted to UFO reports . . . that once an emergency reporting network is established that it is of great value for any type of emergency.

As your local organization grows keep reports coming into your local papers and radio stations. Both your organization and amateur radio can well use the publicity.

If we go about this diligently we can end up with the most complete radio communications organization ever conceived. Even in the smallest of towns there is an amazing number of mobile radio units. In our little town of Peterborough we have police radio, State Police radio, highway department, Forestry Department, fire department, ambulance service, the local vet, any number of CB units, CD communications, CAP, taxis, a construction company, public service, and the phone company. I'll be very interested in plans that are worked out for the coordination of all these services into our net by ops around the country.

If your club is interested in learning more about the UFO problem then I would suggest that your activities chairman write to NICAP, 1536 Connecticut Ave., N.W., Washington, D.C. 20036, and ask if they have anyone in your area who might be able to put on a slide program for the club.

Most of you probably read the Look article on the disgraceful University of Colorado UFO whitewash brought on by our Air Force. NICAP is stepping up its investigation system to fill the breech. I recommend that every amateur interested in the UFO Net join NICAP and coordinate with their local sub-committee. The dues are $5 a year and you get their very interesting UFO Investigator magazine. The current issue, by the way, gives a lot of the inside information on the Colorado debacle. Write NICAP, 1536 Connecticut Ave., Washington, D.C. 20036 and send the $5.

Auto-Call

One basic need we will have for alerting net members will be some simple auto-call system. With the present low cost of IC's we should be able to come up with something reasonably sophisticated and yet relatively inexpensive. How about it you builders out there? Let's see some articles on auto-call systems.

UFO NET SCHEDULE

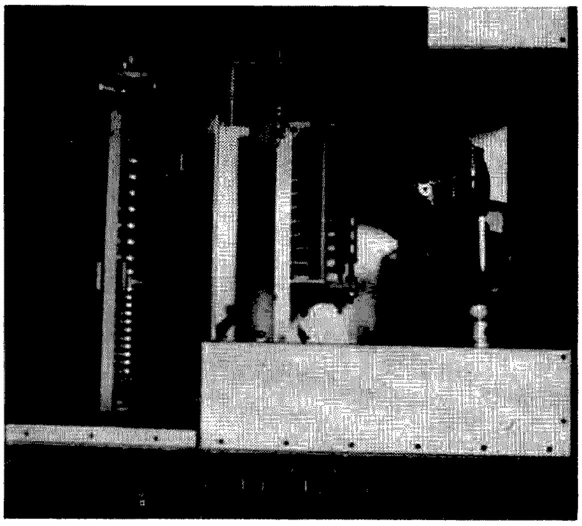
Wednesdays 0200 GMT 14,300
Thursdays 0200 GMT 3950

Turn to page 86

A Terminated Grid Linear Amplifier

James F. Hartley W1DIS
Route 302
Raymond, Maine 04071

An Extremely Stable Configuration



A view of the final to help the home builder to see the parasitic chokes and general layout of the final.

This article will be of interest to the ham who wants a good linear amplifier which is easy to build and very simple to operate. I built mine into the pedestal of a Johnson Viking Kilowatt which will be of interest to owners of this piece of equipment. The type of tetrodes and the amount of power can be almost limitless with this type of circuit. The pair of parallel 4-400 tubes I used gives me a full 2000 P.E.P., with no problems, 80 through 10 meters.

What are the reasons for building a low-impedance, or terminated grid type of amplifier?

1. The input impedance has a resistance of low value. A non-inductive (Globar) resistor of 50 to 100 ohms resistance provides an exciter load suitable for use up to 30 MHz—probably higher. It is non-reactive, except for stray capacity.

2. It requires no input tuning.

3. With proper shielding of the input circuit components, this low input impedance materially reduces problems of feedback from output to input. Neutralization is seldom, if ever, required.

4. Good designs are almost invariably basically simple, and this certainly is simple.

5. Bias may be brought up through an *rf* grid choke, the bias being isolated from the input terminal and the 50 ohm resistor by a low voltage mica condenser of .001 to .01.
Alternatively, the 50 ohm resistor may serve as an input resistor, bias being brought up through it, in which case the low side of the resistor should be adequately by-passed.

6. An additional refinement is that a 100 K pot. (approx) could be connected into the bias lead to provide alc voltage for the exciter. This value of resistance would provide about 10 volts peak when grid current reached 1/10 of 1 mA. The exact values would have to be determined for the amount of alc voltage desired. Moreover, the moving arm of this pot. would have to go to a silicon rectifier diode connected to provide a negative alc voltage. Since any grid current flowing would already represent one rectification, the voltage taken from the pot would be audio; the second rectifier thus would provide an envelope voltage for application to an appropriate stage in the exciter.

Fig. 1 shows the linear amplifier using a pair of Eimac 4-400s in parallel class AB-1 as it is now installed in the pedestal of my Viking Kilowatt. In my rig the grid circuit reflects a 52 ohm load to the exciter at all times. This makes my Drake T-4X operate as if it were working into a 52 ohm dummy

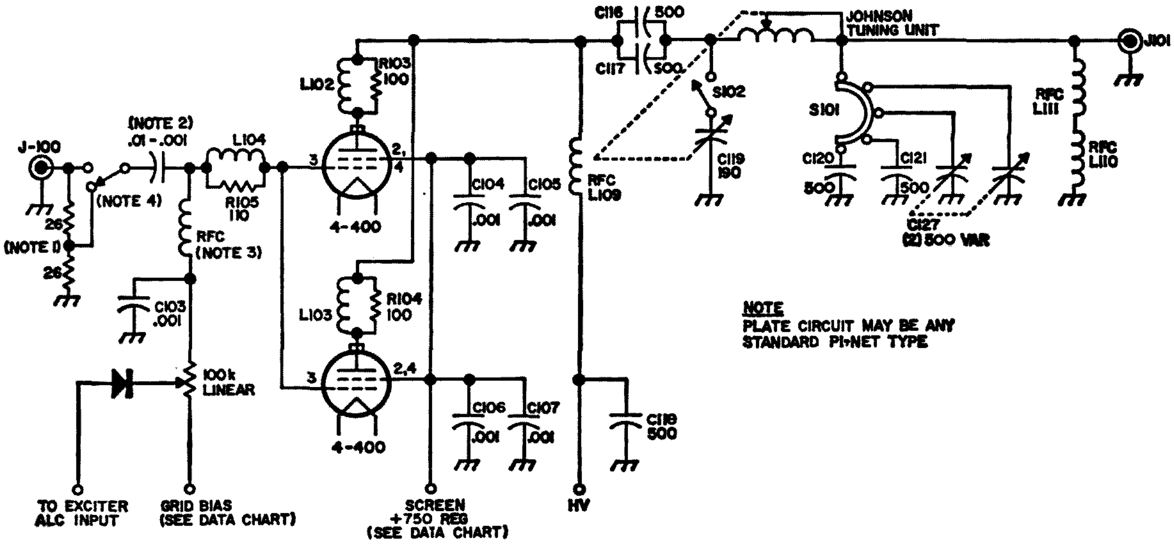


Fig. 1. The basic circuit of the amplifier, Note 1. Grid resistor load. Note 2. Mica condenser any size. 01 to .002 voltage is low. Note 3. National R-100 or equal 2.5 mH. Note 4. Switch for adjusting power output of exciter to proper power input to amplifier. See text for details.

load. Most exciters are made to operate into 52 ohms, and I feel it is only sensible to follow along with the designers plan. Terminating resistance as high as 100 ohms can be used without the linear becoming unstable. There is only one reason I can see to use 100 ohms for termination, and that would be if you were using an exciter that had under 100 watts P.E.P. output and it could not drive the linear on the higher frequency bands. I would suggest trying the 52 ohms first and if more drive is required, put in a larger terminating resistor.

My terminating resistors are made up of two 26 ohm resistors, in series, with a switch in the grid circuit so I can tap down from full power input to place just half the rf into the grid. If I see my alc circuit operating when I am on full input with the exciter gain reduced, I switch to the 26 ohm position and increase the exciter gain. I find that some exciters drop off in output on 15 and 10 meters. I suggest using the 52 ohms on these bands and then using 26 ohms on 20-40 and 80 if this is your problem. I plan very soon to use parallel resistors to make 13 ohms. I will use four of these packages in series for a total of 52 ohms. I will then have a four position switch so I can tap the grid down every 13 ohms. The circuit diagram only shows two positions as I am now operating the rig.

Refer to the Typical Operation Data for the 4-400 tubes (**Fig. 2.**) You should obtain this information for the particular type of

Typical Operation Eimac 4-400 Tubes
Class-AB1 R-F Linear Amplifier
Frequencies to 110 MHz *per tube*

dc plate voltage	3000	3500	4000 Volts
dc screen voltage	810	750	705 Volts
dc grid voltage**	—140	—135	—130 Volts
Zero-signal dc plate current	90	75	65 per tube
Single tone rf (peak) grid volts	140	135	130 Volts
Single tone dc plate current	300	280	250 mA
Single tone dc screen current	18	15	11 mA
Single tone dc grid current	0	0	0 mA
Single tone plate power input	900	980	1000 Watts
Single tone plate power output	500	600	650 Watts
Two tone average dc plate current	215	200	175 mA
Two tone average dc screen current	4.0	3.0	2.0 mA

NOTE **Adjust grid voltage to give stated zero-signal dc plate current

Fig. 2. Typical operation data for the 4-400 tubes.

tetrode you plan to use, and compare the voltages you can get from the power supplies at hand with what the manufacturer recommends. In my case the Viking Kilowatt power supply gave 2750 volts under load. This was not the 3000 volts shown on the chart but it was "make do".

My screen supply was giving me 600 volts into 4-VR 150 regulator tubes, and was

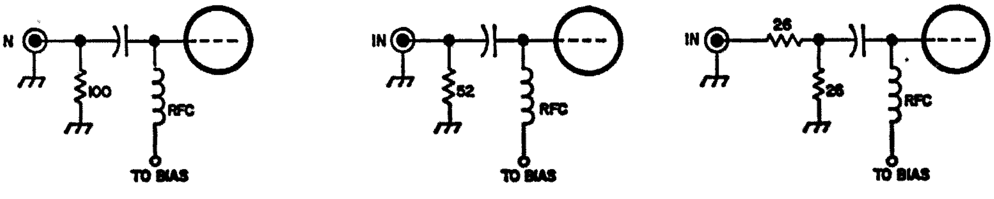


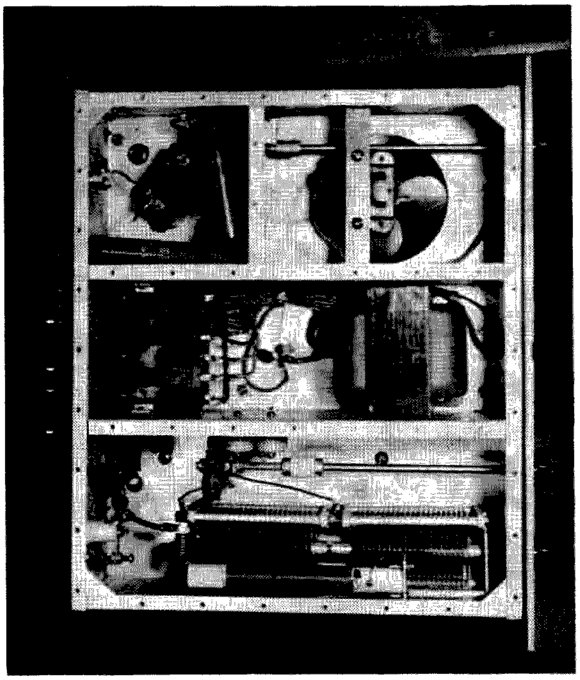
Fig. 3. Terminating resistors for A. Exciters under 100 *watts using* 100 *ohms, B. Exciters in the* 200 *watt range using* 52 *ohms, and C. Exciters over* 200 *watts using* 26 *ohms.*

wired up as choke input. I needed more voltage so a 2 mfd 2000 volt filter condenser was placed from B plus to ground ahead of the choke. With condenser input I got 840 volts to get my required 810 volts as per the data sheet. However when I tried to get regulators totaling 810 volts (4-VR 150 and 2-VR 105 in series), I found the supply would not keep the regulators fired up under modulation peaks, so I had to settle for 5 VR 150 in series for 750 regulated volts; and the output of the rig is not at all impaired. I have adjusted my Zero signal dc plate current to 95 mA per tube, or 190 mA total, because I am running less than 3000 volts on the plates. I merely interpolated the typical data to fit the voltages available to me.

There are two points I want to make. First, if you use a grid meter an 0-1 mA will do the job. If you are operating properly, it should never read anyhow. My rig had a 50 mA unit in it but by removing R-108, a 2.2 ohm shunt resistor, it now reads 5 mA full scale and serves as a check on overdrive. Second, be sure to use a screen current meter as it will tell you more about how the linear is operating than any other meter you can use. The unit I had in the rig was a 50 mA but I should say anything from 25 to 100 mA would do.

I have found from watching my linear on a scope as I operate, that if it shows over 10 mA screen current, the final is not fully loaded. I load mine to about 2 mA and the data sheet says 4 mA. I also note that if I load to the point where the screen current goes negative I am overloading the linear. Keep the screen current positive and in the area of a very few mA at most and you won't have much trouble with complaints. The meter should not fluctuate greatly under load and the screen voltage must be regulated. Be sure that the VR tubes keep conducting (stay blue inside) under all speech conditions. These precautions will not preclude the use of a scope if you can afford one. I feel all high powered amplifiers should have the closest control of operating conditions that can be had. After all big power, not properly controlled, can make big trouble for a lot of hams operating on the band many kilohertz away from your frequency. The more power you use, the more responsibility you have to keep your signal clean. This is one good reason for considering building this simple linear.

For a plate meter, I used the 750 mA meter that was in the rig. All it is good



This view of the bottom of the linear shows where the coils were located and now contains the four resistors obtained from John Meshna Jr. A pair in parallel for 26 ohms and two sets in series to make 52 ohms at about 200 watts. The blocking condenser is a bigger one than needed but was handy in the junk box.

for, along with a voltmeter in the plate supply, is to indicate the power input to the final, as required by FCC on 2000 PEP linears. I never use it to indicate the function of the plate loading on the tubes. I feel the screen meter does a far better job.

The data on the tubes shows a two tone average plate current per tube of 215 mA or a total, with a pair of tubes, of 430 mA. This is almost 1200 watts input and over the legal limit. If I swing the tubes from the standing current of 190 mA in my rig up to 350 mA by the meter reading, I am getting 2000 watts P.E.P. from the power

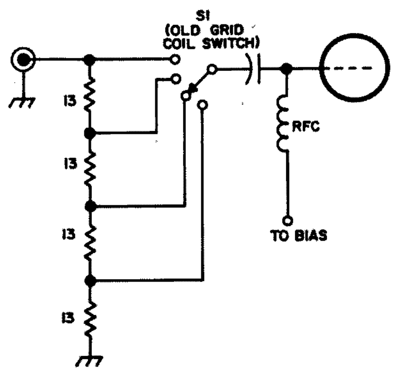


Fig. 4. The deluxe grid switch circuit.

supply into the amplifier. Going over this amount is not legal power input to your final.

I would recommend the use of the alc circuit in the grid of the linear if your exciter has the provisions for this voltage. If you use the adjustable input to the grids of the 4-400s this feature might not be so necessary. However it is so simple to add, I see no reason for not using it.

I would suggest some sort of rf output meter be used with this rig. Between watching the screen current and the rf output, you should get the rig properly tuned. The February 1967 *73 Magazine* showed how to have a combination plate current and rf output meter. See page 23 in the article by W5MPX. Since the plate meter is not too important, it seems a good idea to put it to a better use by throwing a switch.

This linear amplifier can be operated on CW in the AB-1 condition. You will key your exciter, and use it in the standard CW condition. If your exciter in CW has more than enough power to drive the linear and you want to be right on the ball, I suggest adding bias until the drive is just enough to do the job. This will tend to operate the final closer to class C, and the plate dissipation will be less during stand by periods. This is also true when using vox control. Use the contacts on the antenna change over relay to place higher cut off bias on the tubes during receive conditions, and return the bias for the standing plate current when in the transmit condition.

Now to spend just a moment on the terminating resistor. This resistor does not have to be right on the button. Your exciter will make allowances if your surplus resistors should be off a little. If you want to buy resistors, and you don't intend to pour rf into them for minutes on end as a dummy load, I might suggest some 10% 2 watt carbon jobs. For the deluxe job **Fig. 4** why not place 5 each 68 ohm 2 watt in parallel for 13 ohms and place four of these assemblies in series. This would give a 40 watt resistor, which should handle most exciters if the load is not held too long. Although I have not tried it, I should think one of the Heath Kit dummy loads or the Cantenna placed in the line from the exciter to the final with a coax T fitting would also do the trick. A recent catalogue prices the two watt resistors at 20¢ each. The terminating resistor should not be too expensive unless you want to get into a full dummy load type, then noninductive surplus items would be best.

For those readers who have the Viking Kilowatt and wish to change it over, I can assure you that you will double the output of the unit before you start to flat top. Also you will no longer have the loading problem with the grid tuning and there will be no need for attenuators between the

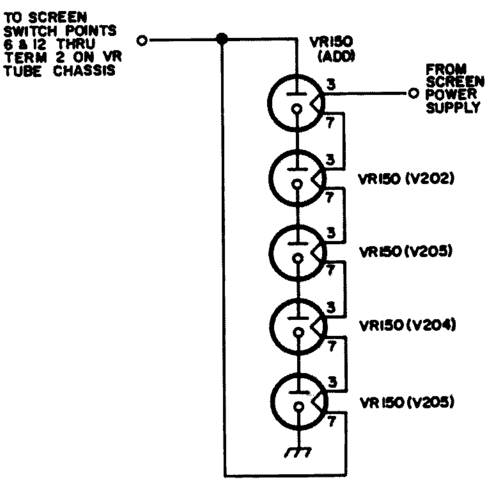
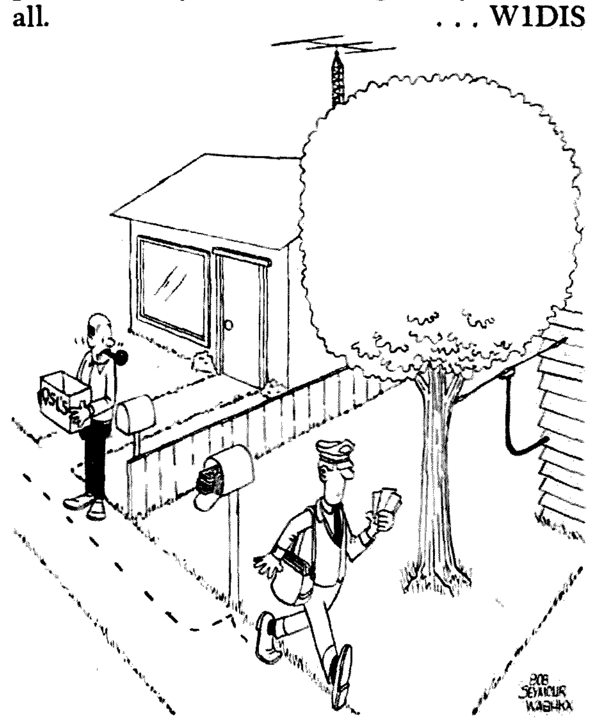


Fig. 5. Screen voltage regulation as changed in Viking Kilowatt.

exciter and linear. I suggest you leave in the 810 modulators as a bleeder. They will help regulate the plate voltage and improve the signal. When my 810s give out I doubt if I will replace them as they make a costly bleeder. The change in the screen supply has been covered. I added one outboard socket on the VR tube chassis so that I could have a string of 5-VR 150 tubes. Actually you could do away with the grid bias control tube (you won't need controlled bias on SSB), and use this for the fifth VR-150. Where you removed the old tuning condenser you can mount the alc potentiameter, and the drive switch now has the old band switch location. The changes do not make any outward appearance change in the equipment.

The greatest operating pleasure this linear has given me so far is this. With the old circuit, no matter how hard I tried (and with my scope showing a perfect picture), I would have about one call a week from a fellow ham complaining about by borad signal and asking that I cut the gain. I might not have changed the gain control for weeks and all seemed normal. However by adjusting the drive and the grid tuning or the neutralization my problem would disappear. With the present rig, I think I have been called perhaps three times in a year for wide signal complaints, and I have found if you watch the screen meter instead of the plate meter you shouldn't get any calls at all. . . . W1DIS



A Unique Transistorized Inverter

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Lexington, Kentucky 40504

Recently, when confronted with the problem of operating a surplus vacuum tube receiver from the automobile supply, it was decided to use a transistorized inverter circuit to supply approximately 300 vdc at 50 or 60 mA. After a search through a reasonable amount of literature, I discovered a serious drawback to transistor inverter circuits. The most usual case is one in which an elaborate transformer (usually having five windings) is used in a push-pull class B arrangement with the extra windings usually for feedback. If this transformer can be purchased after three months of letter writing it is usually expensive. The other alternative is to wind your own transformer by "bopping" down to your local distributor and purchasing so much Z-PTR-XLP-21 transformer core, assorted enameled wire, and various insulating materials. If one is lucky enough to finally get his transformer wound, it is a feat to be proud of.

If only a standard "off-the-shelf" transformer could be used it would be a tremendous help. The circuit shown is such a device. A standard 12.6 vct filament transformer is used in reverse, driven push-pull with a pair of large power transistors, which in turn are driven by a conventional astable multivibrator. PNP transistors are used for the multi, so that base current in the power transistors can be accurately controlled. The

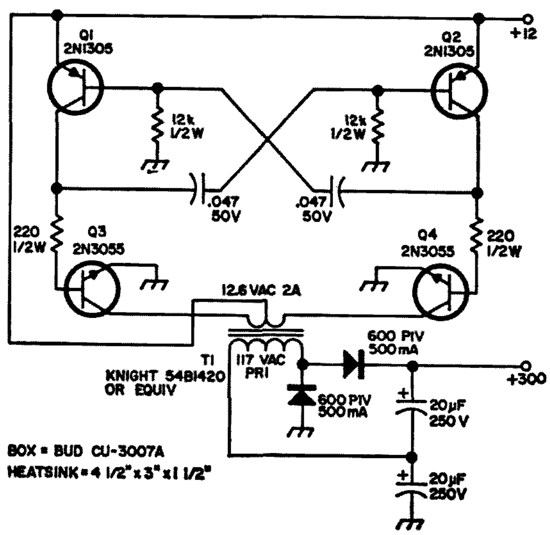

Fig. 1. Transistor Inverter supply.

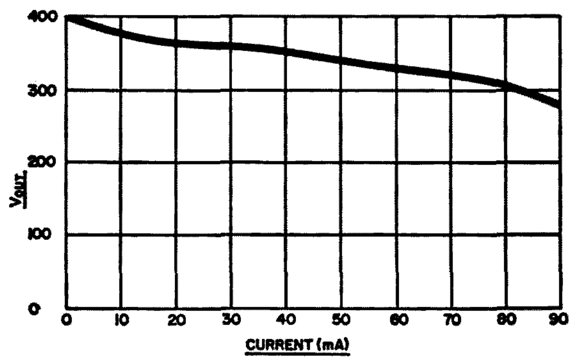

Fig. 2. DC output voltage vs. output current.

circuit configuration also provides high isolation between the oscillator and amplifier. The 2N1305's are very inexpensive switching transistors and the entire cost of the oscillator portion is approximately $1.50. Since an inexpensive transformer is used, the cost of the unit is substantially reduced, even though extra circuitry is required to supply the drive to the power transistors. The power transistors are specified as 2N3055's but the circuit is very flexible, and any of the "bargain-type" NPN power transistors should work equally well, although to guarantee operation with minimum debugging it would be best to stick to the circuit components listed.

The frequency of oscillation is approximately 1500 Hz. This frequency allows good filtering with small capacitance and yet is low enough to enable a reasonable amount of power to be transferred through the transformer. A half wave voltage doubling circuit is used, but this is entirely up to the builder, depending on his particular requirements.

Layout is not at all critical but note, care should be taken that at no time any part of the high voltage circuitry be allowed to come in contact with the transistor circuitry. This would have a devastating effect on the transistor junctions.

The two power transistors can be mounted on one heat sink. Care should be taken to insure that the power transistors are insulated. Mica washers and thermal grease

should be used. Before applying power, an ohmmeter should be used to insure that the power transistors are indeed insulated.

When power is applied, a high pitched whine should be audible, which indicates that the transformer is being driven. If no whine is audible, then place a pair of conventional 2000 ohm earphones from collector to collector of Q_1 and Q_2. The earphones should sing loudly, indicating that the astable circuitry is indeed oscillating. If these tests indicate the circuitry is operating, check for high voltage output. (Note, when this unit is delivering full load it requires approximately 4 amps at 12 vdc). The load curve shown is for 12 vdc input, using component values as listed. To decrease output voltage for a particular load, the resistors R3 and R4 can be increased, but it is not recommended that they be decreased to obtain higher voltages.

The entire cost of the unit is approximately $15.00 depending on the builder's junkbox. The inverter is ideally suited for operating small transceivers similar to the "lunch-box" series. Happy DX-ing.

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Photographic Printed Circuit Process

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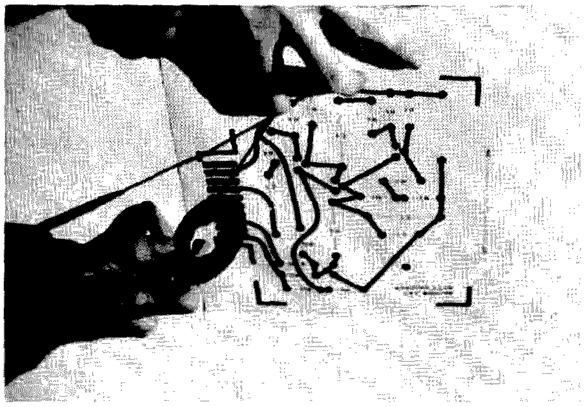
Capitola, Calif.



Printed circuit tape on clear plastic forms the photo master. Tilting and marking is done with dry transfer letters and a felt pen.

Although printed circuits have been around a long time, there are still a surprisingly small number of amateurs who use the technique to it's best advantage: Hundreds of companies manufacture materials necessary for making printed circuits, yet, in spite of this, hams continue to neglect the primary advantage of the etching process; the mass production of circuit boards.

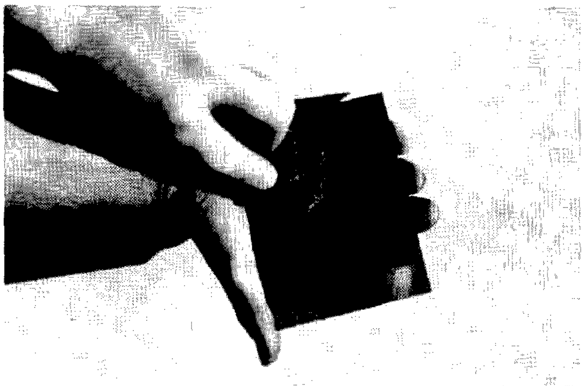
Although of greatest use on club projects, where dozens of the same item are to be made, a mass production process can be of considerable help to the amateur working alone, provided he needs more than one of any item. There are an unlimited number of projects, both private and club, which will go faster, cost less and look better on printed circuits. Besides this, you can make as many boards as you want; each identical to the other. A photographic process is employed but it is not necessary for you to own any photography equipment; not even a camera. Once the chemicals have been purchased (cost will vary from $10 to $25 depending on quantity), each run of boards will cost about $3 not including the board stock.

The process can be divided into two major steps. The first would be the production of a film negative to photoprint the resist on the boards. Making this negative includes laying out the proposed printed circuit on paper. The second step is the printing and etching of the board itself.

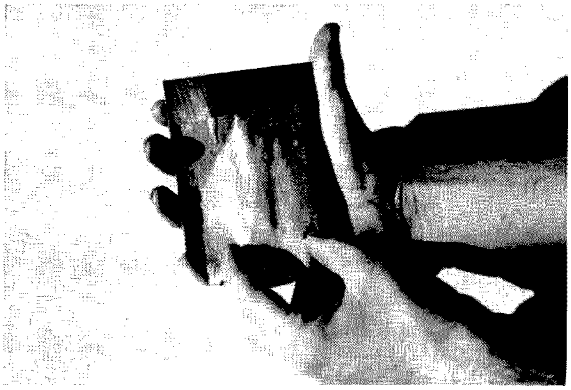
To start the process, a suitable layout of the conductors must be made on paper. Graph paper is used to maintain neat horizontal and vertical lines and the layout is done double size. When a suitable arrangement is arrived at, a piece of clear plastic or a sheet of vellum is laid over the hand drawing

Using tape pads and printed circuit tape, layout the conductor pattern by pasting the tape over the conductors and pads on the drawings. Also use the pads to mark locations for drilling mounting holes. Notice on the sample layout that the corners have been marked with tape in 'L' shapes. These are guide lines for cutting the boards square after printing and etching. The dimension along the side of the layout is necessary for the photographer to reduce the finished product. Since the board is double size the distance between marks measures an actual 4 inches but is labeled 2 inches. When the film negative is made that distance will be an actual 2 inches.

To get the photo work done take your tape master to a blue print supply store that is equipped to do photo work. Ask for a high contrast, film negative of your layout reduced



Cleaning board with steel wool removes oxide which would otherwise hamper etching.



Apply an even coating of photo resist by pulling paper towels across board. Be sure to cover board completely.

to ½ size. A 5 x 7 inch negative will cost about $2.50. If you know an amateur photographer consult him about getting the job done. When you receive the film negative, inspect it for line definition and contrast. Sometimes the clear areas of the film will appear slightly gray. If the grayness is extreme it will cause trouble in printing and the operator can bleach it out of the film for you. Upon reception of the film, protect it at all times from smudges, fingerprints and scratches.

Making circuit boards is a process which has been developed to a fine art by industry and there is no reason why amateurs should not take advantage of their effort. Here is how you do it. First cut your stock to an approximate size allowing about ½ inch extra on all edges. Clean the copper thoroughly with steel wool until it shines brightly, rinse in water and dry with a paper towel (lint free). Now the photosensitive chemical is applied to the board. It is called *Kodak Photo Resist* and is sold in varying sizes by Kodak. Although sold in aerosol cans it is recommended that you stick to hand applications. Don't let the price of the bottle scare you as that little dab goes a long, long way. Apply a thin coat with a small piece of paper towel spreading it evenly all over the board. This work need not be done in complete darkness since the chemical is rather insensitive to low light levels. Just pull the drapes and go to work. Allow the board to dry completely before continuing. Drying can be accelerated by placing the board in the oven at lowest temperature for about 15 minutes.

When the board is dry and cool place it copper side up on a flat, thick piece of plywood. Place the negative on the copper and

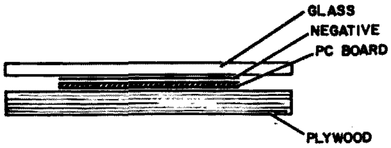


Fig. 1. The 'sandwich' as seen from the side.

center it. Over this, place a piece of clean glass which will keep the negative pressed against the surface of the copper. You now must pick up this 'sandwich' and walk outside with it. Aim the glass side at the sun and hold steady for one minute. The sun should not be obscurred by clouds or be low in the sky when this is done. After exposing, return indoors and immediately place the copper clad board in a shallow, glass dish of Trichloroethylene (sold in electronics parts stores as a cleaning solvent) being sure the entire board is covered with solution. Gently agitate the dish for one minute then remove the board and rinse it under running water for about 30 seconds. Allowing the light to reflect off the board should reveal the impressions of the resist still left on the board. Check for any imperfections at this time. If some exist, the board must be cleaned and the printing process repeated.

The board is now ready for etching. Ferric Chloride is the etchant used and is obtainable from chemical supply houses in crystalline form. Varying size tubes can be bought and the size will be determined by the project. This is by far the cheapest way to purchase the ferric chloride although it can be had in solution from the local drug

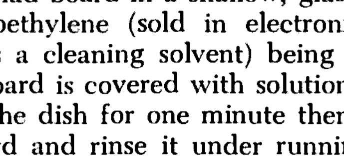
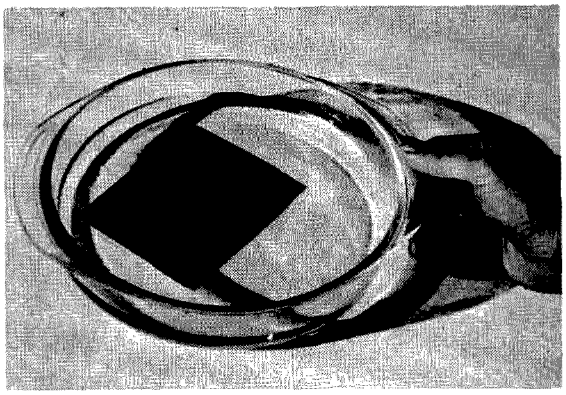


Fig. 2. After etching, a cross section of the printed circuit board will look like this. Copper will remain where there is a coating of photo resist.

store. The crystals which you get are to be mixed in water. The ratio is 8 pounds per gallon of water. Mix until all the crystals are dissolved in the water. Do not use metal containers or utensils with the etchant. You will now find that by dunking a prepared board into the solution it will etch in a couple of hours. There are two methods which will aid in reducing this time to 15 minutes. First of

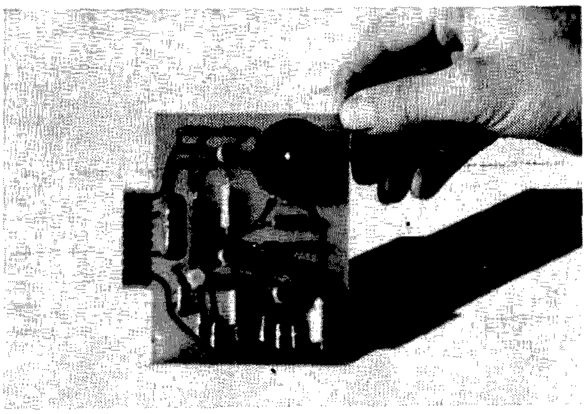


Submerge board in trichlorethalene developer and agitate for one minute. Immediately rinse in water.

all the chemical reaction which is taking place is enhanced by heat. By elevating the temperature of the mixture to 120° Fahrenheit, a great reduction in time will be noted. I would recommend doing this by setting the container of etchant inside a container of water placed on a small hotplate. This allows better control, adds a small bit of safety and allows you to monitor the water temperature instead of the etchant.

Oxygen is also an aid to a faster reaction. A small bubbler with a hose going to the etching tank will speed things up considerably. By suspending the board upside down at the surface of the solution an excellent cutting action is produced as the liquid splashes against the copper. An aquarium type bubbler might be ideal for this and would cost very little.

A few additional hints at this time might prevent some unpleasant experiences. From the time the Kodak Photo Resist is put on the board until the etching is completed it would be wise not to touch the surface of the board. If the layer of resist is scratched it will allow the copper to etch where it is removed. Keep your working areas clean, especially the steel wool section. Those nasty little fibers polute chemicals very easily. Avoid inhaling the fumes from the developer (Trichloroethylene) and the etchant (Ferric Chloride). Both are toxic. Keep the developer covered when not in use as it evaporates quickly. While drying the photo resist coating after application store the board in a warm, dark, dust-free place. The dust particles will print as hairlines on the board. Change developer periodically by observing particles of contamination floating in it. Change etchant solution when the etch time



The finished product with components mounted.

has increased to twice its original value. Never mix new and used chemicals together. Attempts to restore contaminated chemicals result only in greater quantities of poluted chemicals than you started with.

This is the whole printed circuit process in a nutshell. I have used this system with great success on many different projects and am happy to report that it is much easier to do than to say. Below is a list of possible problems which might be encountered in the various stages of production along with their solutions. Also you will find a list of materials for the layout and printing of boards.

Problems	Causes
All the photo resist comes off in the developer. No print left on board after washing in water.	Probably caused by under exposure to the light. Also can be caused by improper drying of resist before exposure.
None of the photo resist comes off the board in developer. No print left on board after washing.	Too much light in room during preparation of board for exposing. Never leave cap off photo resist bottle. Developer bad. Increase developing time.
Resist turns gummy in developer and peels off board.	Coating of resist too thick or not sufficiently dried before continuing.
Print on board after washing appears and disappears in various places. When held to light print is difficult to see.	Coating of resist is too thin. Exposure to light too short. Left in developer too long. Washed board too strenuously or used hot water. Water should be cool.
Board will not etch at all or just in places leaving big splotches of copper.	Unexposed resist was not removed by developer (see above). Board not steel wooled enough.
Print fuzzy on edges of conductors before etching.	Film negative not held tight against the board during exposure.
Print fuzzy on edges after etching.	Left board in etchant too long. Not left in long enough.
Entire board etches leaving no copper.	Coating of resist was applied too thin. Too much light allowed to strike board prior to exposure.

List of materials for layout

Quantity	Item	Source
——	graph paper 1/10 inch squares	stationery store
one	sheet of clear plastic or vellum	stationery store
one	felt tip marker pen—black	stationery store
——	printed circuit pads	electronic supply house
——	printed circuit tape	electronic supply house

List of materials for printing and etching

Quantity	Item	Source
one	bottle of Kodak Photo Resist	photographic-supply store, electronic supply store, direct from Kodak
one	bottle of Trichloroethylene	electronic supply store, druggist
——	Ferric Chloride etchant	druggist, chemical supply house
one	large, glass tray similar to small tropical fish tank (No metal however)	variety or dime store, chemical supply house
two	large, shallow glass trays	
——	paper towels	
one	piece of glass, clean	
one	piece of plywood	
	Optional	
one	small aquarium type bubbler	
one	hot plate, preferably one with thermostat	

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REFERENCE

Ritchie, George L., *Electronic Construction Techniques*, 1st ed. New York, Holt, Rinehart and Winston (1966).

A Simple Method of DSB Conversion

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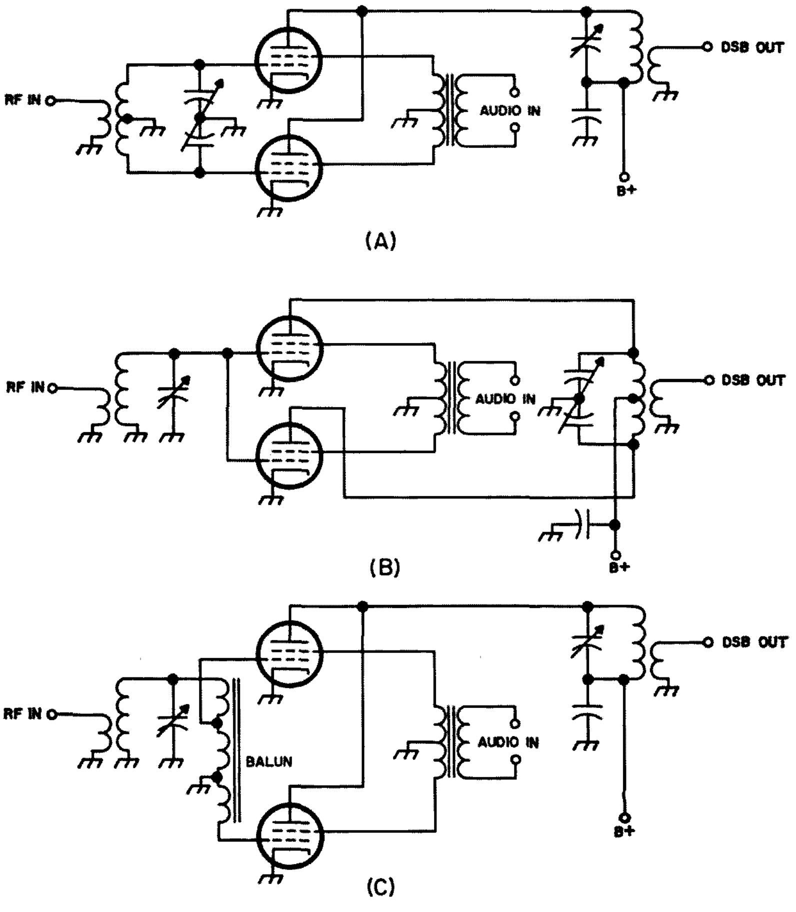


Fig. 1. Basic high-level DSB circuits. Grid biasing arrangements are not not shown.

Here is a simple way to convert any AM transmitter using two tubes in parallel in the output stage to double-sideband suppressed-carrier operation. This conversion is simpler than others I have seen in that the original single-ended grid and plate tuning circuits are used, with only minor changes to be made in the grid circuit.

Theory of operation

Basically what is required for double-sideband suppressed-carrier operation is a push-pull rf grid circuit with a parallel rf plate circuit, **Fig. 1**(a) or a parallel rf grid circuit with a push-pull rf plate circuit, **Fig. 1(b)**, either combination to be modulated by push-pull audio.

The transmitter I converted is home-brew, using a pair of 1625's driven by a 5763, with a pi-network output circuit. I left the output circuit alone and changed the grid circuit to push-pull by adding a broad-band balun between the original single-ended grid tuning circuit and the two grids, **Fig. 1**(c). The balun provides a balanced input to the grids. Each grid is isolated from ground and supplied with a signal 180 degrees out of phase with the other grid. The balun is not tuned; all tuning is done with the original tuned circuit.

Construction

The balun is wound on a .68 inch outside diameter powdered iron toroid form (Ami-

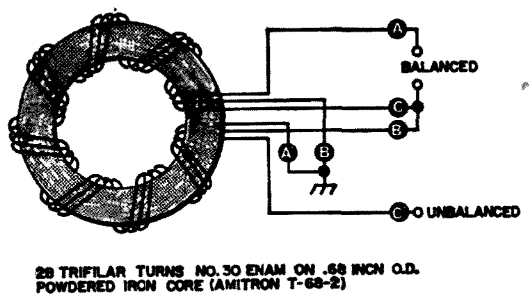


Fig. 2. Balun wiring diagram.

Tron type "E", number T-68-2). This is one of the two cores contained in the Ami-Tron Experimenters Toroid Kit which was purchased locally for $1.50. I had no information on using a balun in a high impedance circuit so I proceeded experimentally and wound three different baluns. See **Fig. 2** for balun wiring diagram.

The first balun was wound with 14 trifilar turns of No. 24 enameled wire (the wire that come in the toroid kit). This worked well on the 40 through 10 meter bands but the 80 meter tuning was shifted several megahertz too high. The second balun was wound with 23 trifilar turns of No 28 enameled wire. With this one the 80 meter band was about one megahertz too high, while the higher bands were still all right.

The third balun, which is the one I used, was wound with 28 trifilar turns of No. 30 enameled wire. This one allowed tuning the 80, 40, and 20 meter bands, but added enough capacitance to put the 15 and 10 meter bands slightly out of the tuning range. This was cured by moving the 15 and 10 meter taps on the grid coil up one turn each. There is no noticeable loss in grid current with the balun on any band.

To wind the balun, cut three 25-inch lengths of No. 30 enameled wire and twist or tape the ends together. Start at the center and wind both ways to make it easier. Feed the wire carefully through the core to avoid kinking and don't allow the wires to cross each other, as this may cut through the insulation. The wires must be close together at the center of the core to allow space for the 28 turns. Tape each end of the winding to the core. I covered the core with thin plastic tape before winding, but this may not be necessary.

I mounted the balun by its leads. This is not very rigid and a stronger mounting should be used for mobile operation or if the rig is moved around much. The balun may be taped or glued to a stand-off insulator of some sort. Just keep it away from the chassis and don't put any metal screws through the center.

Separate grid-leak resistors are required for each tube. Each one should be about twice the value used for parallel operation of the grids. I have measured each grid current separately, and have found them to be very nearly equal. Keep all grid leads as nearly symmetrical as possible and you should have no trouble.

Several methods of modulation are possible. The easiest way to do this with tetrode tubes is to apply push-pull audio to the screen grids. Not much power is needed, but fairly high audio voltages are required. About 300 volts peak is required for a 1625 or 807. No dc screen voltage is needed for tubes in this size class, but with some higher-power tubes a negative screen bias may be needed to keep plate dissipation within the ratings.

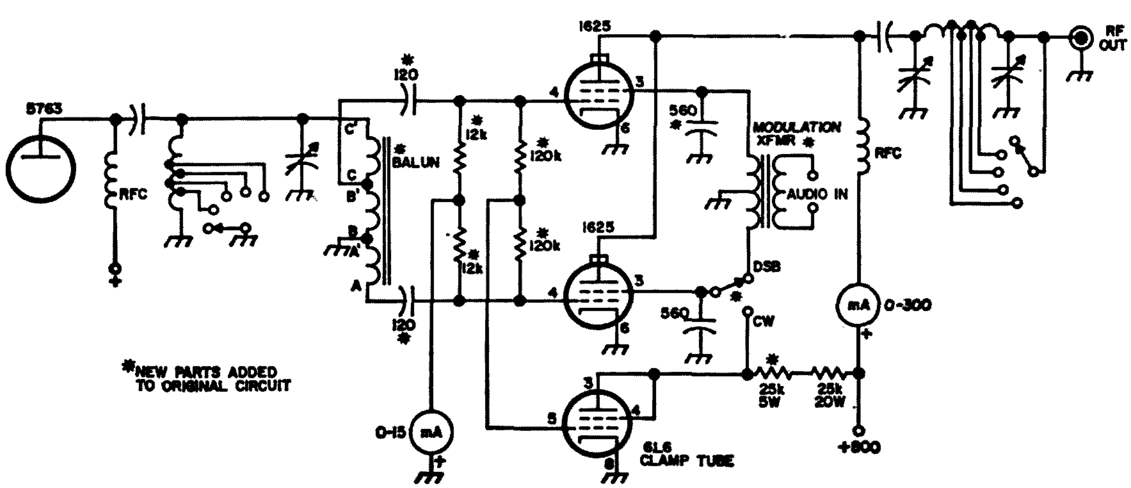


Fig. 3. Circuit diagram of the simple DSB conversion.

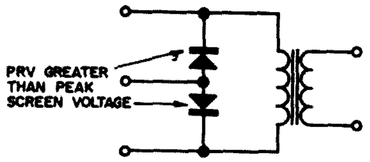


Fig. 4. Diode center tap, for use with modulation transformers that have no center tap.

For a modulation transformer I use a push-pull output transformer from an old auto radio, with the high-impedance windings going to the screens, and the center tap grounded. The low-impedance winding goes to the 16 ohm output of an old Heathkit 6 watt radio amplifier, which is used as a modulator. Anything with a few watts output can be used as long as you choose a transformer with a turns ratio that will give sufficient output voltage, If your modulation transformer has no center tap, a diode center tap, as shown in **Fig. 4**, may be used. The screens must be by-passed for rf but not for audio, so use a maximum of about 1000 pF on each screen.

To get the carrier back for CW operation or tune-up purposes requires only the addition of a single-pole double-throw switch. One screen is switched from the modulation transformer to the screen voltage-dropping resistor. The dropping resistor will need to be twice the resistance value of the original resistor that supplied two tubes. The easiest way is to add another resistor of the same value as the original, in series with the original resistor. This resistor need be only one-quarter of the original wattage value.

The above method uses only one tube for CW operation. To get full power from both tubes on CW, you must add another switch as shown in **Fig. 5**. The grids are simply switched back into parallel, and the screens are supplied through the center tap of the modulation transformer. The original voltage-dropping resistor is used. Be sure to keep the grid leads short and symmetrical. I didn't use this method because I had insufficient room to mount the grid switch. I did try it, however, and it works fine.

I key the cathode of the driver stage in my rig, and protect the final when the key is up with a clamp tube. The dc voltage to operate the clamp tube is taken from the final grids through the 120 k ohm resistors.

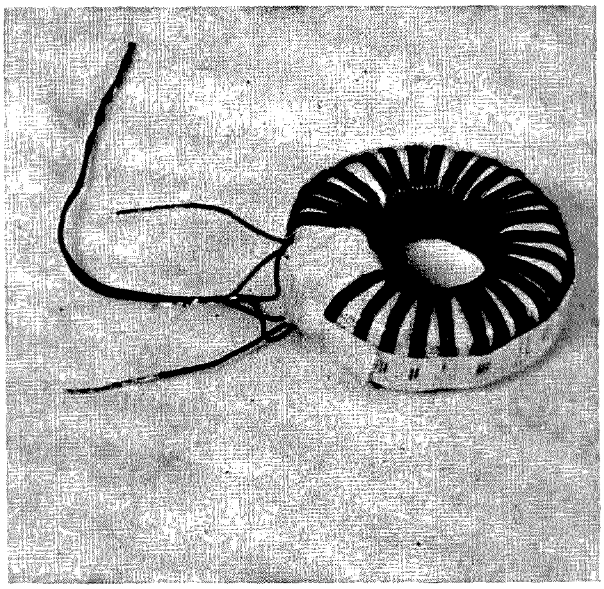
Testing and adjustment

The initial adjustment of any double-sideband transmitter must be done with the aid of an oscilloscope. Connect the output of the transmitter to a dummy load. Couple the vertical plates of the scope to the transmitter. Switch the transmitter to CW, set the grid current at the normal value, and tune for maximum output. Switch to DSB and apply a single-tone audio signal with an audio oscillator or by whistling into the microphone. Increase the audio gain until the peaks begin to flatten, and note the maximum height of the oscilloscope pattern when this occurs. Then speak normally into the microphone and adjust the audio gain until the peaks approach the previously noted level. This is the maximum input which can be applied without causing distortion and the resultant splattering.

An audio compressor or clipper will help to keep the average level high while preventing accidental overdriving. There should be no output noticeable on the scope when no modulation is applied.

The transmitter should always be loaded as heavily as possible. Light loading will cause flat-topping to occur much too soon.

The peak double-sideband power output with a given plate voltage will be about the same as the CW power output from one tube. A considerable increase in power can be obtained by using higher than normal plate voltage. Up to double the AM rating can be used without exceeding the dissipation ratings of the tubes. I use a plate voltage of 800 volts on my pair of 1625's. The



The grid-circuit balun. The over-all size is only ¾ inch diameter by ¼ inch thick.

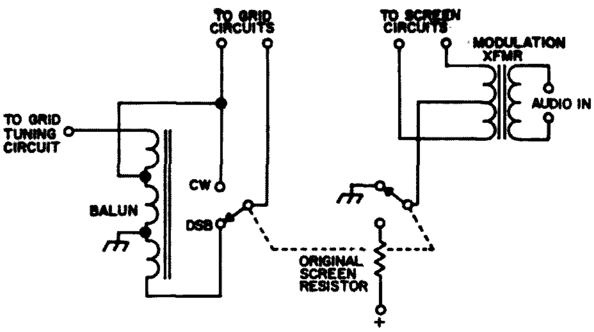


Fig. 5. Modifications necessary to get full power on CW from the circuit of Fig. 3.

dc plate current is 80 mA, with maximum sine-wave audio input before flat-topping occurs. The resting plate current, with no modulation, is about 25 mA. I estimate the peak power output to be about 50 watts.

Results

The on-the-air performance of my low-power DSB rig is hardly spectacular, but I find it easy to make contacts on 20 meters with a dipole antenna. I can now operate in the SSB portion of the band with a clear conscience, knowing that I am causing no heterodyne interference. I believe that DSB is an excellent mode of operation, especially for someone with a good AM or CW rig who wishes to try sideband operation without making a large investment in new equipment.

For more information on baluns, see the "Coaxial Accessory Handbook", 73 Magazine, September 1966. For details on using an oscilloscope for transmitter testing, read "Monitoring an Oscilloscope," 73 Magazine, July 1967, or any handbook.

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Navy RTTY Book Published

RTTY enthusiasts will want to keep their library complete by ordering this new book from the Superintendant of Documents, Washington, D.C., 20402, for $1.50. It is called Principles of Telegraphy (Teletypewriter) and has the designation "Navships 0967-255-0010."

P of T starts in with the basics of the TT system, covers the history and development of the field and goes into just about all phases of modern TT operation. It is about 200 pages and is well worth while for every RTTY'er. Newcomers to RTTY will find the explanation of the TT systems and codes of particular value.

Basic High Frequency Receiving Converter

W. B. Cameron WA4UZM
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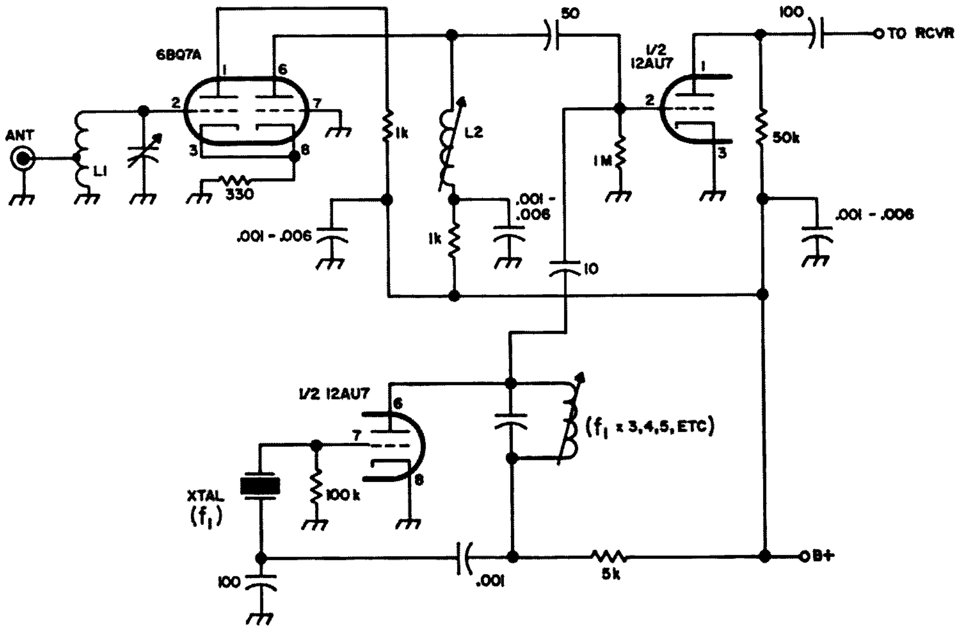


There have been many articles published over the years describing converters to extend the range of otherwise satisfactory low frequency receivers. This article does not present a unique design, but rather a successful combination of previously published circuits which, taken together, have the advantage of simplicity, dependability, and easy adaptation to a wide range of frequencies and a variety of applications.

If we consider the requirements for a good rf amplifier, it should provide efficient energy transfer from the antenna to the mixer; enough amplification to overcome internal mixer noise; a low degree of noise introduced by the amplifier itself; a low degree of cross modulation in the presence of strong adjacent signals; and a moderate amount of selectivity (a requirement which will vary from one application to another). In practical design compromises are required.

We may fairly assume that most receivers to which we will want to attach converters use tubes rather than transistors; consequently, we may as well use tubes in the converter as well. Pentodes provide high amplification and good selectivity but often with poor intermodulation characteristics and fairly high amounts of noise. Triodes, in contrast, have good noise figure, less selectivity, lower amplification, and fair intermodulation characteristics.

The rf amplifier shown utilizes two similar triodes, cathode-coupled. This has several advantages. Cathode coupling provides good energy transfer between the two stages and the circuit is not prone to oscillation so long as the antenna loading is adequate. With a typical amateur antenna system fed by a transmission line of fifty to three hundred ohms, it is easy to get good signal coupling to the first grid by adjusting the tap on the coil L1. Raising the tap will increase the coupling and by loading the circuit it will broaden the tuning, which is desirable in many applications. Try one-third up from the bottom as a first approximation. Note that this coil is resonated with a variable capacitor, which allows for the easiest adjustment at the front panel when changing antennas

or moving to different parts of the band.

The plate coil L2 is shown as slug-tuned. It may be necessary to shunt this coil with capacity to reach the proper frequency, and if the response is too critical it may be necessary to shunt it also with a resistance of ten thousand ohms or less to reduce the Q and thereby broaden the frequency response. Generally, it is a good plan to resonate L2 near the high frequency portions of the band to be covered and resonate LI near the low end. Some published versions of the circuit show an rf choke between the junction of the two cathodes and the resistor which goes to ground. This increases the efficiency, but I usually omit it. It is also possible to make the cathode resistor variable and adjust it for optimum gain. The 330 ohm value shown is generally adequate.

The resistors in the B+ lines to the rf amplifier (here shown as one thousand ohms) are not critical as to value and can be omitted entirely if the power supply is located close to the rest of the components on the converter chassis. However, they do provide additional decoupling, if needed, and as they are hardly larger than a piece of wire and not very expensive it may be a good plan to include them.

This option does not apply to the 5000 ohm resistor feeding the oscillator, which is an essential part of the rf voltage dividing network. (It could, however, be replaced with a suitable rf choke). The oscillator shown here is a particularly good one for developing output at some harmonic of the fundamental frequency of the crystal. I have used this with common surplus FT243 crystals to produce 3rd, 4th, 5th, and 6th harmonics. Output decreases as you go higher. Where the converter oscillator operates on a relatively low frequency, and a crystal for the fundamental frequency is available, a simpler Pierce-type oscillator can be used, thereby eliminating a few components.

Note that the output of the mixer stage is not tuned. This means that images will be present in this output and we depend entirely upon the front end selectivity of the tunable receiver which follows the converter to eliminate them. Image rejection can be improved by adding a tuned mixer plate circuit, although this will restrict the bandpass characteristics beyond what is desirable for some applications. In many situations, the amateur may find it convenient merely to change the crystal if some one strong local image falls in a portion of the band which he wants to use.

Fixed capacitors shown should be either mica or high quality ceramic. Coils can be wound on any suitable material, including forms salvaged from old TV sets. The easiest way to make them is "cut-and-try," checking as you go with a grid-dip oscillator. The circuit in general is sufficiently uncritical that layout imposes no great problem and any convenient arrangement of parts should serve. It is well to separate the coils so that they do not directly interact.

Tubes also are not critical. The 6BQ7A connected as shown provides a satisfactory noise figure up through the six-meter band, although at this point, and on higher frequencies, improvement would be found by substituting nuvisters. There is nothing magical about a 12AU7 as an oscillator-mixer, but they are plentiful and work well on this circuit. Other triodes can be used if available. Power supply requirements are slight, and 150 volts B+ is entirely adequate.

In some units where I needed a converter of this description to be separately powered, I have salvaged the power supply from an old TV preselector, and found it entirely adequate. An alternative output circuit might be to put a resistor in the cathode of the mixer and take the output signal from the cathode. In such a case, the mixer plate load resistance would be reduced to zero or merely to a 1000 ohm decoupling resistor as in the rf stages.

Since this circuit is so simple, inexpensive, and dependable, it is a good one to pass on to the novice who is just getting started building equipment and needs the encouragement of success in each project. However, it is also good enough that I have several of these in operation in various kinds of gear and have virtually given up experimenting with any other circuit, after having tried nearly all that I have seen published over the years. In short, it is not the best, but it will do a very good job.

. . . WA4UZM

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

3 on 20 for 15

Steve Rock WA4YVQ/4
4474 Lauderdale Ave.
Virginia Beach, Va. 23455

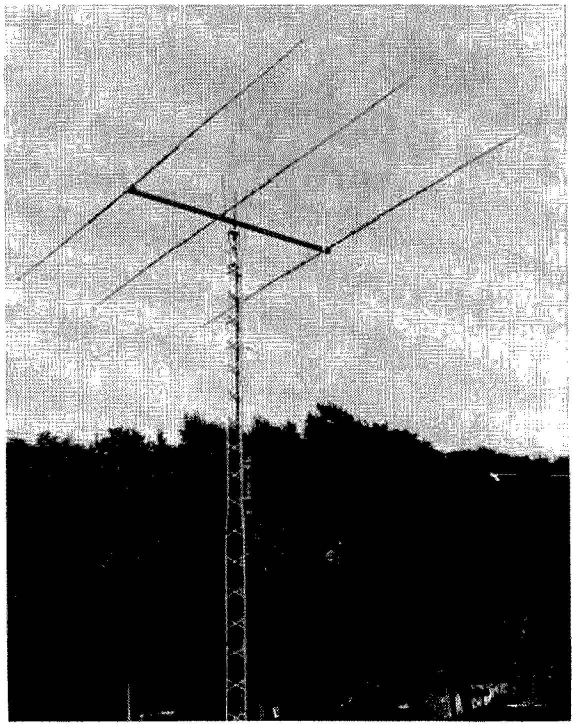
Dollars that is!

About a year and a half ago I felt a great desire to operate on 20 meters. Verticals and dipoles were tried with disappointing results. Several types of homemade beams were tried, but they either didn't work as advertised, or fell prey to the weather.

After much frustration I tried a "ZL Special". Not only was this antenna a fine performer, but it was also very inexpensive to build, and it withstood the weather very well.

Using information attained from the ARRL Antenna Handbook and the Dec. 1965 issue of *QST*, I constructed a three element "ZL Special". My results indicated that the idea was good, but the antenna needed to be refined. Electrically it was good, but as is the case with any beam, the mechanical construction was where most of the problems arose. Since that first beam was constructed several more have been built, utilizing new ideas that occured to me.

My goal was to build an antenna that would be inexpensive to build, light enough



View of the installed antenna. The antenna is clamped to the mast by two U-bolts and is attached at the antennas center of gravity. The boom is guyed to the rotor mast to assure that the antenna remains horizontal.

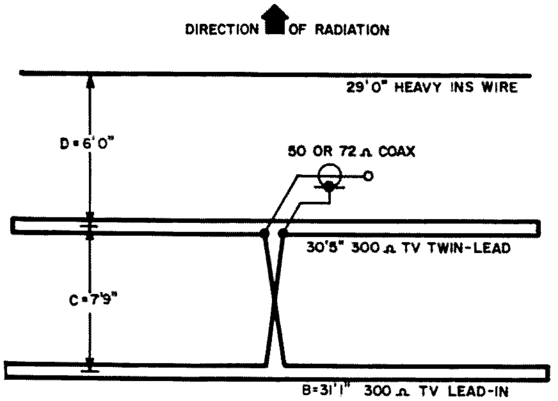


Fig. 1. The 300 *ohm twinlead is shorted on each end. The above assembly is taped to the beam framework. Measurements are shown for* 20 *meters* (14.2). *For the other bands use these formulas.*

$A = 430/\mathit{frequency\ MHz}$
$B = 447/\mathit{frequency\ MHz}$
$C = 101/\mathit{frequency\ MHz}$
$D = 0.1\ \mathit{wavelength}$
$E = 10\%\ \mathit{less\ than}\ A$

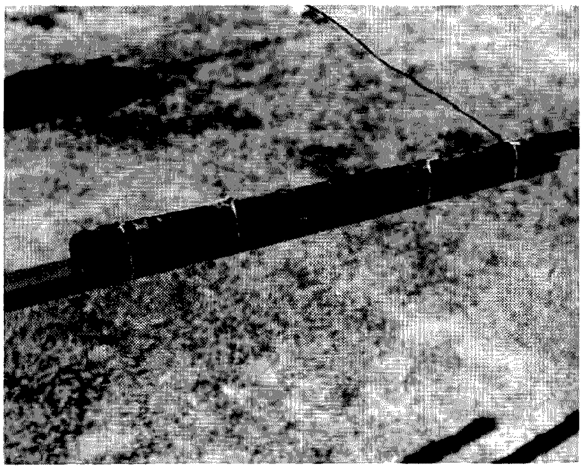
for one person to handle, strong enough to take the windy weather the Virginia Coast is known for, and to perform as well as a commercial beam.

The following article is designed as a guideline in the construction of this fine antenna. The cost, will to a large extent, depend upon the contents of your junkbox. My cost was $15.00 and I have a very limited junkbox.

The following material will be needed

- 75 feet good quality 300 ohm flat TV lead-in wire
- 29 feet #12 plastic covered wire (any heavy covered wire)
- 1–14 foot 2 x 4 (I used fir as it is light and strong)
- 3–10 foot lengths of 1 x 2

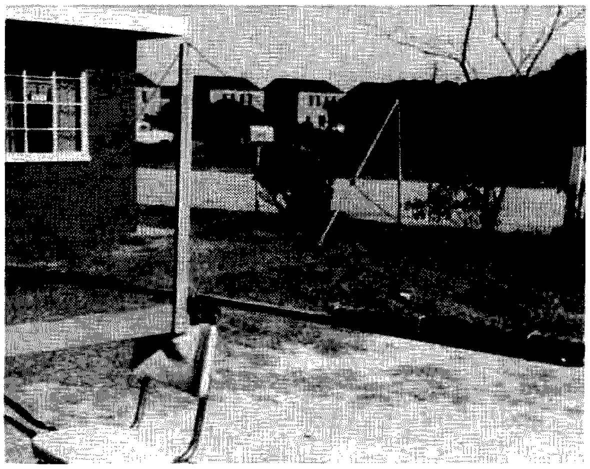
3— 3 foot lengths of 1 x 2
6—15 foot bamboo poles (It pays to select these very carefully as they will determine, for the most part, the appearance of the finished antenna.)
6—3½ x ¼ inch stove bolts with nuts and washers
Tape, nails, varnish, 50 feet guy wire, U-bolts, small screweyes etc.



Detail showing how the bamboo poles are connected to the 1x2 boards. The wire used is regular 6 strand guy wire. The wire wraps are taped over with electricians tape after the final coat of varnish has been applied.

Before actual construction begins, several coats of a high grade exterior varnish should be applied to all wooden parts.

Most of the details of construction can be seen in the photographs and diagrams, however, several things should be pointed out. If wire is to be used for the element guys, it should be insulated from the TV wire elements by several layers of tape. The reason being that sometimes, when using high power, the TV lead broke down around the bare element guy wire and arcing occurred. The 180° twist in the 7'9" phasing line is most important and the antenna will not work properly if it is omitted. The length of the parasitic director is figured to be 10% less than that of the forward driven element. The spacing between the parasitic director and the forward driven element is figured to be .1 wavelength. The height and location of the antenna will have quite an effect on the SWR. Most of these antennas require some trimming. Remove an equal amount of wire from both ends of each element when trimming. The ends of the driven elements are shorted together and all the elements are taped to the top of the beam's frame-

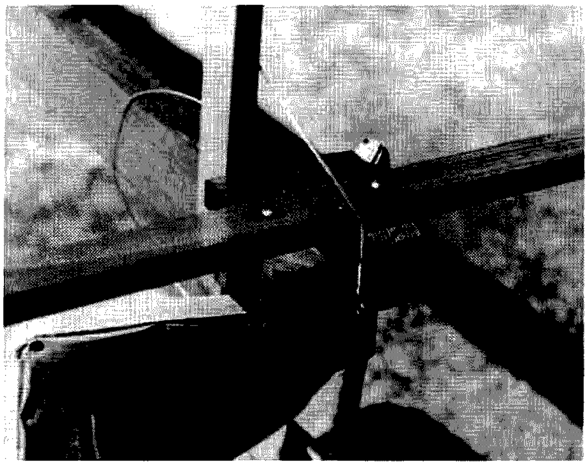


Detail of the element guy mast construction and use. Another set of guys is installed to a point about halfway down the length of each bamboo pole. See text for details.

work. Either 72 or 52 ohm co-ax may be used. 72 ohm seems to give the better match.

The performance of this antenna has been most gratifying. Front to back ratio seems to be about 30 db. and the forward gain is about 6 to 8 db. Even though the size of this beam is rather large, I have no trouble putting it up or taking it down from my tower. The weight is about 25 pounds.

For a person with a limited budget this antenna is the answer. I'm not so sure that this wouldn't be the most practical and the least expensive antenna for those of us who only use one of the "DX Bands". Using the formulas given, you can also construct this antenna for 10 or 15 meters. . . . WA4YVQ/4



Detail of tne element to boom connection. Small blocks on either side of the boom are for added strength. The small piece of 1x2 between the element guy mast and the element, is used to make sure the element stays square with the boom. This type of assembly is used on all 3 elements. Note the small screw eye in the end of the boom used for the boom guy.

Mini Boom Quad

Walter C. Jordan VE6FS
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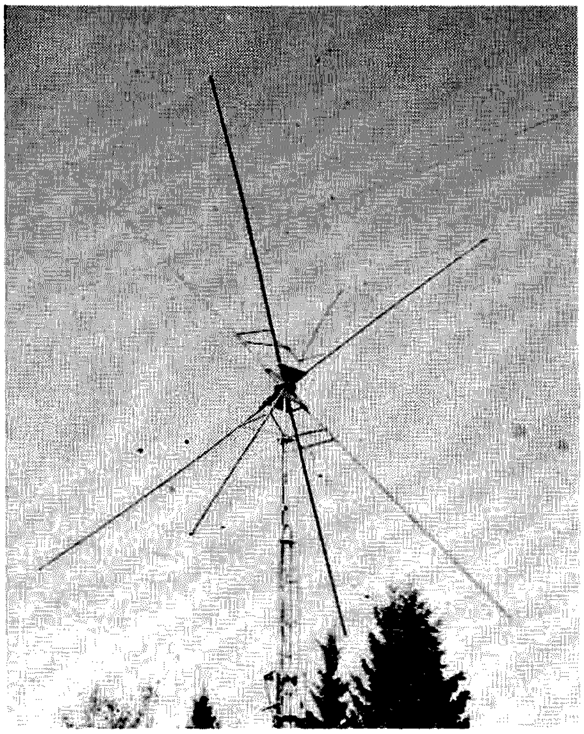


The Author's interest has been directed for some time to various types of antennas. Wishing to build a Quad for ten and twenty I found it necessary to sum up what I considered the weaker points of such antennas in this area.

First of all this area is subject at times to winds ranging from a mere breeze to 100 mile per hour and let's be honest fellows, any antenna regardless of construction takes a beating under these conditions.

So with this in mind and after much experimenting with different boom lengths the antenna I wanted would have to meet the following requirements.

1) It would have to be as light as possible so that it could be raised or lowered in a few minutes by one man.

(2) It must be of rigid construction and full electrical size.

(3) It must be economical to build.

The Mini Boom Quad I am about to describe is the result of experiments at this QTH, This antenna which weighs a mere 37 pounds is easily raised or lowered with the aid of a home brew tilt over tower.

You will note that Bamboo Poles converge to a more or less central point, in effect the poles are the boom. This makes for rigid construction as the poles brace themselves in each plane when wires are drawn taut and turnbuckles tightened.

I have made the angles in the two parasitics section rigid whereas the angles in the 9 foot spacing is adjustable to facilitate assembly and final adjustment.

As you will note in close up photo I used a piece of 1¼ inch pipe 30 inches long on top of which I welded a twelve inch phono turn table (any light metal would do here and eight inch diameter would suffice) I then reamed the center of turntable and pipe to allow a piece of wood dowel one inch by forty two inches to be driven into pipe leaving thirty inches above turntable.

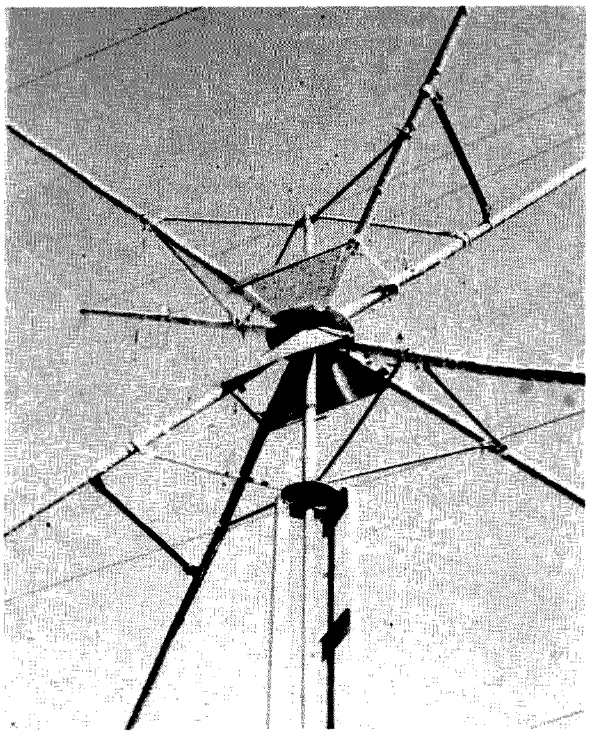
I then centered the four small hinges on the top and bottom of the turntable, using the short side of the hinge nearest the mast. These in turn are bolted or welded in position, the four pieces of sheet metal are then centered on the hinges and bolted.

With my mast lowered to its horizontal position, and with the aid of a small scaffold, I slid this assembly over my rotator drive shaft which is one inch pipe. This was then drilled and bolted.

I then oriented this assembly so that the rigid angle was facing down, the four bamboo poles were clamped in position, the assembly rolled over, and the remaining poles clamped in position.

The nine foot spacing sections were measured and spacers clamped to the poles. Space these at least 9'8" to allow for any slight wow you may find in the poles and make a tighter job.

The parasitic sections are then measured, clamped and spaced between pole and mast. When squaring these sections in position, it will help to string the wire and temporarily tie them in position. The final position of the twenty meter wire will be close to the thirteen foot spot as measured from the center of the mast, and it is better when making these spacers to install clamps to the poles first and measure to get the length of the spacer. Light aluminum pipe or conduit, cut to size, flattened on the ends and drilled to



fit will make good spacers. The turnbuckles and guy wire were then installed and tightened and the remaining wires were strung in position, Small weatherproof nylon cord was then installed between the ends of the nine foot spaced poles and drawn taut into final position.

With this nylon cord and small turnbuckles it is possible to come up with a real zinging tight job.

Fifteen foot bamboo poles were used and the ends cut to approximately thirteen foot when the final positioning and tightening were done.

Twenty four gauge galvanized sheet metal was used for the pole angle mounts, and I intend to punch a number of one inch holes in these mounts and will clip all bolts short, this will further lighten the antenna.

Measurements for the square loops can be obtained in most handbooks and will depend on which portion of the band you wish to operate. I find the resonant point quite sharp and intend to further experiment with different size wires to broaden response.

All bolts used were three sixteenths galvanized, the clamps are made from aluminum sheet.

Finally, I might add that this project is merely a new approach to mounting an otherwise good antenna.

During the last three months this antenna has withstood winds of sixty mile an hour without any noticeable effects, when the nine foot side is headed into wind it shows very little wind resistance.

In conclusion my thanks to Joe Parsons VE6PD for the very fine job of photography.

. . . VE6FS

D. E. Hausman VE3BUE

Ventilation by Elevation

An important consideration in the operation of radio equipment is proper ventilation. When high heat is present, electrolytic capacitors dry out and lose capacity, VFO's drift, vacuum tubes burn out, and overall performance becomes unreliable. The best way to overcome high heat is the installation of a cooling fan; but this is quite expensive for the average ham. A simpler, although not as good a solution, is to separate each piece of gear from the other. When gear is stacked, this means the use of spacers. Two aluminum or steel square tubes about 1½ inches sq. will do the job nicely. The length of each tube is the same as the depth of the gear it supports. As an added bonus, the inside of the tubes can be used to hold pencils; indeed a useful feature.

The Collinear Resurrected

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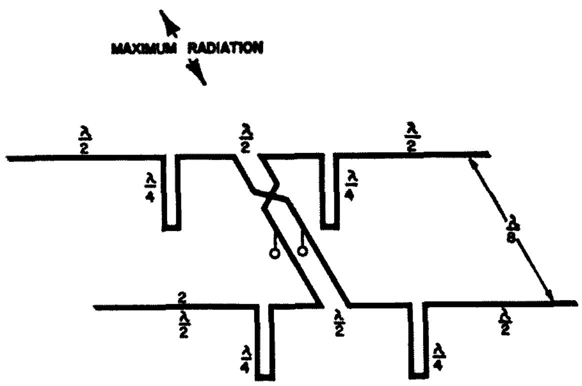

Fig. 1. The spacing is distorted to make clear how the two collinears are fed. The half-turn in the connecting line is vital! But make sure it is in one side only.

There are undoubtedly many hams who would like the gain of a beam or a quad in their shacks, but cannot convince XYL, landlord, or neighbors of the wisdom of their desires. For such unfortunate souls it is necessary to construct wire arrays if any significant signal gain is to be achieved along with continuing diplomatic relations.

There are many problems to be solved in the construction of a three- or four-element wire beam. Even assuming that proper element lengths and spacings can be found and a decent match achieved, there remains the problem of supporting the thing. For a three-element beam it is necessary to have six trees or other objects in convenient places, or else a mile of rope is required to keep everything properly positioned.

For the ham who experiences QRM from unsympathetic people but does not wish to fight with a wire beam, there is a solution. The solution is the construction of an end-fire driven array of elements.

The big advantages of end-fire arrays are that they are not critical of tuning, and they can be constructed with very close element spacing without sacrificing performance. This in turn means that two supports are sufficient to hold up this type of antenna. This is readily seen from **Fig. 1.**

So why aren't such arrays in more common use? The reasons seem to be, first, that few hams know how well they work, and, second, that no one knows how to use anything but coax to feed antennas. This is quite understandable as a partial result of the rise of transceivers. It is more convenient for the manufacturer and for the mobile operator, and it happens to work with whips and other mobile antennas, to equip transceivers with output circuits that will feed fifty ohms and melt with anything else. Unfortunately a driven array will usually exhibit an impedance of hundreds or thousands of ohms. It cannot be driven well through coax (let alone fixed-tuned output circuits) unless baluns are used at the antenna. Hence the unpopularity of driven arrays. However, satisfactory feed to a high impedance array is not nearly so difficult as one might think, and later on the problem of feed will be discussed.

The six-element array at WA1DVB (cut for 20 meter CW) is shown in **Fig. 1.** It has a theoretical gain of 7.7 db., a bi-directional radiation pattern with half-power points only 25° away from the line of maximum radiation (perpendicular to the elements), and, for anyone already curious, a driving impedance of 150-200 ohms, depending on height and proximity to conductive objects.

In practice, the QTH required that one pair of elements pass eight feet over a copper roof, and that the feedline be brought away from the antenna feed point almost parallel with the elements (ideally it should drop straight down for at least a quarter

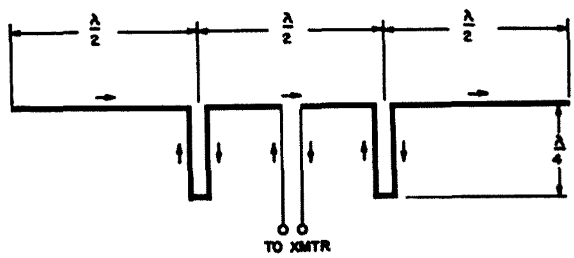

Fig. 2. Pattern of current distribution along a collinear antenna.

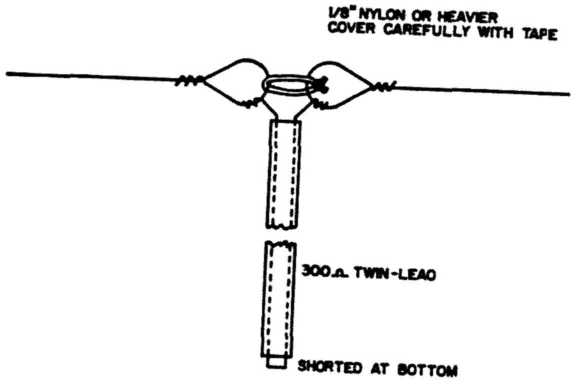

Fig. 3. The "It ain't beautiful, but it works" method of connecting the collinear elements.

wavelength). Nevertheless, in comparison with a dipole that was parallel to the array, six feet higher and clear of obstructions, signal reports along the array's major line of radiation were consistently two or three S-units better than they were on the dipole (this was due as much to the low angle of radiation as to the gain). Running 150 watts input with the array one-half wavelength off the ground, reports of S7 and S8 are typical from VK land, even though that area is more than 45 degrees off the line of major radiation. (The half-power points, by the way, were determined by comparing received signal strengths on the array with received signal strengths on the dipole, assuming a figure-8 radiation pattern for the dipole.)

The array is simple in theory. The phasing sections in each collinear are intended to keep "wrong-way" currents off the horizontal elements. The current distribution in either of the collinears is shown in Fig. 2. It can be seen that the collinear is nothing more than an improved long wire. An end-fire array results when two or more collinears are positioned in such a way that out-of phase feeding produces significant gain in the plane of the elements, and perpendicular to the elements.

It should be mentioned that any number of elements can be hooked together in collinear fashion as long as phasing sections are used between half-wave sections of the wire. It is not necessary that there be an equal number of elements on each side of the center-fed element, though symmetry does help to distribute approximately equal currents to each element. In any case, for anyone wishing to try a collinear of any size, the driving impedance will be under 500 ohms for any reasonable number of elements, because the array is fed at a current loop. The gain of a single collinear is theoretically 1.9 db for two elements, 3.2 db for three elements, 4.3 db for four elements, 5.3 db for five elements, and 6.3 db for six elements. Use of a pair of out-of phase collinears adds about 4.5 db to these figures. Thus the gain of the WA1DVB array is estimated at 3.2 db + 4.5 db, or 7.7 db.

A collinear array can also be fed between elements, but this configuration generally presents an extremely high impedance to the transmission line. Center feed of one element is to be preferred for simplicity of matching.

It has been determined in practice that optimum spacing between collinears of an end-fire array is about one-eighth wavelength. Spacing can be between one-fifteenth and one-quarter wavelength without significant sacrifice of gain. Discussion of this point is impractical here. However, it should be considered that extremely close spacings may result in serious impedance changes being caused by winds during operation.

The dimensions of the 20-meter CW array are:

elements (#14-#18 copper)..................33'4"
phasing sections (300 ohm twinlead)....14'3"
spacing between collinears...................... 8'9"

The elements were connected in accordance with the if-it-works-it's-good-practice theory. Fig. 3 shows how each pair of collinear elements was connected.

There is considerable tension on the rope as the antenna is raised to the horizontal, so it seems best to use nothing less than one-eighth inch nylon (or the equivalent) rope. The tension can be even greater if either end is connected to a tree that is subject to whipping by the wind. If the connections are properly made, there should be no strain on the twinlead phasing sections.

Fig. 4 gives dimensions for collinear arrays for each end of 40, 20, 15, and 10 meters.

If a pair of collinears with its 4.5 db additional gain is decided upon, it is essential that the collinears be fed out of phase (feeding in phase will send your signal straight up!). This is accomplished most easily by connecting the two collinears at their feed points with open-wire line or 300-ohm twin-

frequency	7000	7300	14000	14350	21000	21450	28000	29700
element length	66'9"	64'0"	33'4"	32'7"	22'3"	21'9"	16'8"	15'9"
phasing sections	28'10"	27'8"	14'3"	14'1"	9'7"	9'5"	7'2"	6'10"
spacing between collinears	17'7"	16'10"	8'9"	8'7"	5'10"	5'9"	4'5"	4'2"

Fig. 4. The spacing given is one-eighth wavelength; it may be varied by as much as +100% or —50% without significant loss of gain.

lead (being sure to twist it one-half turn) and feeding the connecting line at its center.

And now to touch briefly on the subject of matching. Low SWR is not nearly as important as many amateurs think in achieving effective matching—*as long as low-loss transmission line is used.* As a *conservative* rule of thumb, the total loss in open-wire line may be considered to be insignificant if the SWR is below 20:1 and the line is less than 200 feet long, or if the SWR is below 10:1 and the line is less than 600 feet long. With an SWR of 4:1, the line may run over a quarter mile with negligible loss! These figures are conservative for 10 meters and below. The requirements for coax or twinlead are much stricter, of course, which accounts for the common dread of high SWR. Clearly the best way to feed any antenna and avoid matching headaches is to use open-wire line. As long as the transmitter can feed the transmission line, you may be confident that the power will find its way to the antenna.

Admittedly, a very low impedance antenna such as a close-spaced beam may require a Matchbox to keep the SWR on open-wire line below 20:1. But such a low impedance would do no better with coax feed over any distance than with the open-wire line, because the inherent losses of the coax would easily equal the SWR losses of the open-wire line. So clearly open-wire line is the safest way to feed *any* antenna. If the transmitter contains an unbalanced output network such as the pi-network, it may be advisable to use balun coils, but even these may not be necessary in many cases. If the impedance of the line is above the range of the pi-network, 4:1 balun coils will probably solve the problem.

As a final note, in case you should have trouble finding copper wire for your antenna, look around for a motor repair shop. They will probably sell you wire for less than it would cost from a mail-order house.

. . . WA1DVB

Built-in Microphone Preamplifier Clipper

John J. Schultz W2EEY/1
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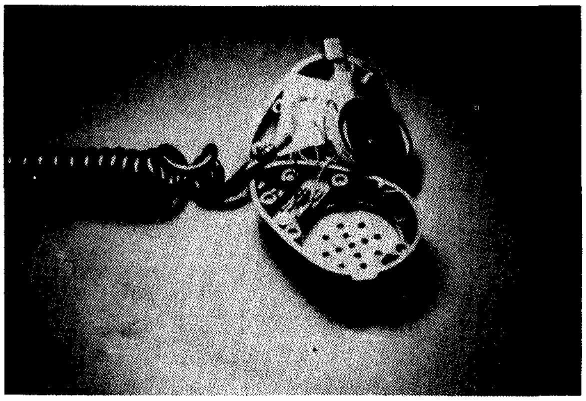
Mystic, Conn. 06355



Clippers, for fixed station installation, have gone out of style in recent years, being replaced by compressor amplifiers. However, for mobile installations with AM or FM transmitters, they are still very appropriate. This article presents a particularly compact and simple, but effective, clipper circuit for the mobile operator.

Clipping circuits no longer find much application in home stations because of the use of SSB. Although the amplitude of the harmonics generated by diode clippers decreases quite rapidly in amplitude (as the square of the harmonic order), they still produce undesirable modulation effects in SSB transmitters. However, for use with AM or FM transmitters in mobile installations, a simple clipper still has great value in maintaining a high average modulation percentage.

The circuit described in this article provides both a preamplication and clipping action and, because of the small components used, can be built directly into most mobile microphone cases. The circuit of the unit is shown in **Fig. 1.** It was adapted from a hearing-aid circuit which was developed to provide improved symmetrical clipping action. A speech waveform can be clipped to a great degree without destroying intelligibility, but any slight phase shift in the waveform components will destroy intelligibility very rapidly.

Since phase stability is a function of the symmetry of the clipping action, it is important that the positive and negative variations of the input waveform be limited equally to a close degree. This is accomplished by the use of a pair of carefully matched diodes in the circuit.

Almost any small signal diode can be used and the diodes can either be matched by testing their characteristics, or a pair of matched diodes can be purchased (for instance, a pair of IN541 diodes, sold as a matched pair for use in FM detectors, costs less than a dollar).

The circuit must operate from a high impedance microphone. It will not operate properly with some of the low impedance dynamic mobile microphones (300 to 1,000 ohms) because sufficient voltage is not developed to allow proper clipping action by the diodes. Aside from the diodes, the circuit is that of a simple transistorized audio amplifier.

The photograph shows the placement of the clipper stage in the housing of a typical mobile microphone. The components are simply assembled on a piece of vector board shaped to fit into an empty corner of the enclosure. A thin piece of foam plastic or rubber material is glued on the bottom of the vector board. The foam material is, in

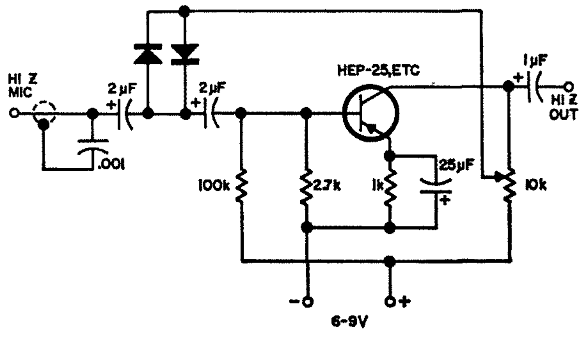


Fig. 1. Circuit of the preamplifier clipper circuit. Potentiometer adjusts clipping level and may be replaced by fixed resistors once desired level is found.

turn, glued on each corner to the microphone enclosure.

The power for the amplifier can be supplied in any one of several ways. A miniature battery might fit in the particular microphone used and could be wired to extra contacts on the push-to-talk switch, so the clipper is only energized during transmit periods.

The power can also be supplied from the transmitter via the microphone cable. Some cables have an unused conductor (normally used as a ground connection in addition to the cable shield) which can be employed. Otherwise, the only possibilities are to replace the cable with one having an extra conductor or to feed the dc voltage over the microphone lead itself using coupling capacitors and miniature audio chokes at both ends of the cable, to separate the dc and audio voltages.

The potentiometer shown in **Fig. 1** can be used to set the clipping level. Once a suitable setting is found, it can be replaced by fixed resistors. For a more versatile installation, a miniature potentiometer could also be used and brought out to the back of the microphone enclosure as a screwdriver adjustment.

The adjustment for best clipping level can be best done in conjunction with another station. The cooperating station should adjust the rf gain control on the receiver used so that the received signal is as weak as possible, while still being intelligible. The amount of clipping is then adjusted to produce the best signal readability at the minimum possible setting of the rf gain control.

. . . W2EEY/1

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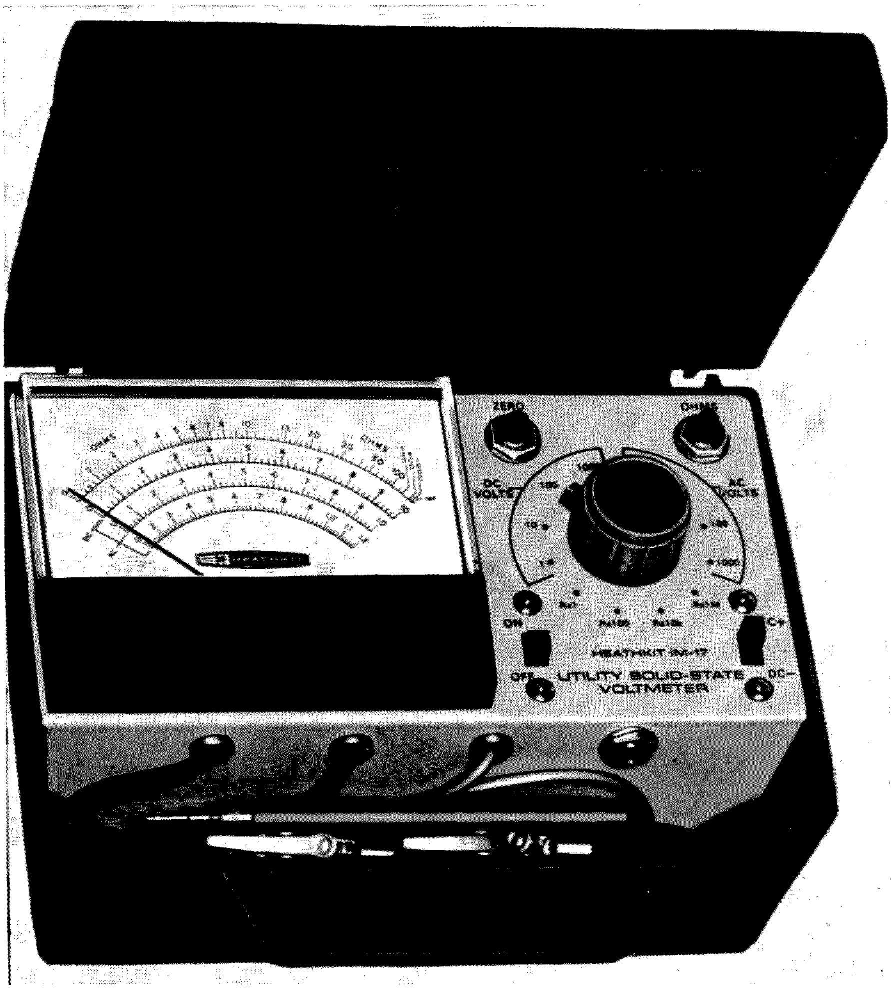
An Evaluation of the Heathkit IM-17 Solid State Voltmeter

Walter Pfiester W2TQK
Box 85
Tully, New York 13159



Still tied to the 110-volt line with a VTVM? After several hours of hunting for my test leads, pulling out an extension cord, warming up of the VTVM, I decided to invest in a good solid state voltmeter. At a price lower than most VOM's the Heath-IM-17 fills the bill for a high impedance voltmeter.

Construction

Total time, from opening the shipping carton to complete calibration, was only 5½ hours. The majority of the components are mounted on a well designed heavy printed circuit board and front panel. The selector switch is rather unusual in that it is very uncluttered, a refreshing change for an old test equipment man. As usual, Heath has a very well constructed assembly manual using pictorials and fold-out pages to their best advantage. By following the manual carefully, even the novice will experience no trouble in construction with this kit. The packaging is uniquely Heath. A hinged black polypropylene case houses the basic instrument, probes and power supply (two batteries). This case serves to protect the meter when not in use, (covering the face of the instrument). In addition, the case makes it possible to measure voltages both

of which are "hot," since the case does not conduct. An accessory jack is included for other probes, such as high voltage, demodulator, rf, etc.

Circuitry

Basically, this high impedance (11 megohm) meter does not depart from its vacuum tube counterpart in either circuitry or operation. dc and ac voltages are handled in the same manner, with the exception of a half wave peak detector for ac. A string of 1% resistors make up the voltage divider chain. The output of this divider feeds both a protection circuit and the gate of a field effect transistor. The FET is source-coupled to a transistorized balanced bridge. This bridge may be considered as a differential dc amplifier whose current difference (a function of the measured voltage) is measured by a 200 A meter between the emitters of the bridge.

There is one unique circuit worthy of consideration in this instrument. The overload protection circuit which is used in the instrument. It is not immediately apparent how this circuit operates. When either zener is in a nonconducting state, the gate of the FET remains at a high impedance. If, however, the breakdown or the zeners is reached, either Q_1 or Q_2 will conduct depending upon the polarity of the offending voltage, protecting the FET. Another feature found only in higher priced instruments is meter protection (when the meter is not in use). The meter is shorted out when the power switch is placed in the "off" position.

All the components in this kit are of high quality and of a reliable grade. With normal use, this instrument should last a lifetime. The batteries used are a 1.5-volt C battery and an 8.4-volt mercury battery. The mercury battery may be difficult to obtain, however, the standard 9 volt battery (NEDA #1611) will work just as well. I have used both at home. If it is desirable to obtain an 8.4-volt battery, Mallory makes one which should be available from any large sales outlet. The Mallory number is TR 133.

Operation

Calibration of the meter was performed as set forth in the manual without any special precautions. I checked the accuracy with laboratory standard equipment and found that all specs were complied with that were set forth by Heath. The use of the instrument is very easy and will pose no problem to the VTVM user. A large portion of the assembly manual is devoted to the use of the instrument for the novice, and as a review for the advanced test equipment man. Functionally, all knobs are placed in such a way to make the instrument more versatile and impossible to knock out by accidentally hitting either the zero or ohms pot. The ohmmeter, once set on the highest range need not be reset on any other range, and the zero will hold for voltage measurements as well.

Specifications

DC Voltmeter	
Ranges	0-1, 0-10, 0-100, 0-1000 volts full scale
Input Resistance	11 megohms on all ranges
Accuracy	±3% of full scale
DC Voltmeter	
Ranges	0-1, 0-10, 0-100, 0-1000 volts full scale
Input Resistance	11 megohms on all ranges
Accuracy	±3% of full scale
AC Voltmeter	
Ranges	0-1.2, 0-10, 0-100, 0-1000 volts full scale
Input Resistance	1 megohm on all ranges
Input-Capacitance	Approximately 100 pF (38 pF on 1000 V range)
Accuracy	±5% of full scale
Frequency Response	±1 dB 10 Hz to 1 MHz (from low source impedance)
General	
Ohmmeter Ranges	Rx1, Rx100, Rx10k, Rx1M
Ohms Circuit Power Supply	1.5 volts (C-Cells, NEDA #14)
Amplifier Circuit Power Supply	8.4 volt Mercury Cell (NEDA #1611)
Meter	4¼", 200 A, 100 degree movement
Transistor-Diode Complement	1—FET (field effect transistor) 4—silicon transistors (2N3393, or equivalent) 1—silicon diode
Dimensions	8½" wide x 4¼" high x 7¼" deep
Net Weight	2½ lbs.

With the price at only $20, ease of operation, and accuracy, there is no excuse for anyone not being able to make valid measurements of dc, ac, or resistance. It's the biggest bargain in a solid state voltmeter today.

. . . W2TQK

Hamwriting

Your ideas on paper can put your hobby on a paying basis

Ken Sessions, Jr. K6MVH
4861 Ramona Place
Ontario, CA 91762

Amateur radio has a widespread reputation for being an expensive hobby; however, an increasing number of amateurs will attest to the fact that ham radio *can* pay for itself. Interest in amateur radio, for instance, can lead to technical competence —a prerequisite for a career in electronics.

There are, of course, a great many of us whose careers are already solidly established—who are satisfied with our vocations. We approach ham radio as a hobby and nothing more. But *even as a hobby, amateur radio can be a lucrative source of extra income.*

You can put your own station on a paying basis by merely reporting your own personal ideas to fellow amateurs! How? By the simple expedient of writing these original ideas and observations and submitting them to this very amateur journal in the form of articles. Whether it's a new receiver or transmitter you want or merely the cash to pay for your license renewal, what better source is there than a publisher's check for material *you* created?

Completely disregarding the financial aspects of writing, there's a special kind of thrill that comes with seeing your name as a byline on a published article. It's something akin to snagging a rare DX contact when you know the band is alive with listeners. The thrill is just the same for the tenth contact as it was for the first.

How about you? Maybe you're saying, "I'd write something, but I don't have any new ideas" or "How could I write an article when I even flunked English 1A?" Perhaps you feel your technical knowhow is too limited. The plain truth is that *anyone* can write a salable article; the simple requirements are *careful thought* in planning, *organization* of thought in preparation, and *thoughtful care* in presentation. There is no rule stating that a published author must be a graduate engineer. Nor is there a requirement that he be particularly proficient in English. Perhaps the most important single requirement is *originality.* This simply means that you must report your ideas in your own individual way.

Ideas for Articles

Somebody famous once said, "There's nothing new under the sun." The statement bears a lot of truth. Yet original material is published month after month after month. Here's why: The material itself is not necessarily new or novel, but the author's *approach* to it is. This is where *careful thought* comes in. Think about it. Do you know a tried-and-true shortcut for performing a normally time-consuming chore? Have you a better or simpler circuit than the one the rest of us are using? Has your junkbox been particularly productive? Do you have *any* ideas that would benefit other amateurs? Of course you do.

And how about your friends? Have any of them come up with something of general interest to amateurs? The article you write must be your own work, but *what you write about* need not be. Here's an example: During 1964, a group of us local amateurs became very active in six-meter AM transmitter-hunting. We were plagued constantly with high ignition noise and low signal levels—a problem characteristic of six-meter mobile operation. One of the fellows experimented with noise-clipper design, and came up with an extremely efficient and tiny solid-state module that could be easily incorporated into any tube-type AM receiver. His device worked so well that the rest of us built up duplicates for our own receivers. It occurred to me that there were perhaps hundreds or even thousands of six-meter mobile operators across the country who were encountering ignition problems too severe for their built-in limiters. So I wrote an article about it, crediting the design to its originator (Dick Hughes, W6CCD). It was his idea, his design; I just reported it. And 73 bought it for its January 1965 issue.

The secret of *careful thought* in article writing is this: If the idea would be of

general interest or usefulness, report it. The article need not be technically oriented, either; this one isn't. It must appeal to the amateur radio operator. It can be humerous or informative. Or it can be just plain helpful, as in this case: My six-meter AM days brought TV interference problems that all six-meter operators in crowded communities face. I learned rapidly that amateurs often find it difficult to communicate with televiewing neighbors during times of interference. So I drafted a blanket letter to my neighbors explaining the TV's weaknesses with respect to the problem of adjacent-channel operation. After distributing it, my complaints virtually disappeared and I found myself furnishing other local amateurs with multiple copies of the letter. If it worked locally, why not nationally? With a few introductory paragraphs, the "letter" became an article, and 73 Magazine published it in February 1966.

If any real talent is required in the writing of articles for amateur radio publications, that talent is nothing more than the capacity for recognizing information that will be of specific interest to readers. And this is what is meant by *careful thought*.

Planning Your Article

The most important thing to remember when you're preparing an article is to be *accurate*. What could be more damaging to an editor than publishing a description of a circuit that is technically unsound? The reputation of the magazine goes on the line with every issue. It doesn't take many "bum dope" articles to mar the image of a solid publication. The embarrassment of unsound circuitry extends to the author, too. Once your manuscript has been committed to print, it is there for the eyes of the world to see. If you ever want an editor to read your second manuscript, you'd better make sure the information in your first one is correct and accurate in every detail.

Mistakes in transcription are another problem. These are serious, all right, but they are by no means catastrophic. No editor will "blackball" you for misspelled words or reversed leads in a schematic. But the mistakes had better be few.

I overlooked the absence of a short vertical line on a schematic in "VHF Operation By Remote Control" (73 Magazine, April 1968), and received letters from all parts

of the country asking about it. You can be assured those readers are going to be particularly cautious when they refer to future published circuits of mine. When I think of what it cost me to send out individual letters of explanation to all those readers, I get even more convinced that *next* time I'll be a lot more careful. Don't just check your schematics; double-check them, triple-check them, and have one of your friends check them. And when you *know* it's right, check it again!

When your article is in the planning stages, don't hesitate to write. Jot down notes, ideas, facts, sketches—anything that will help you in the final preparation. Don't rush it. No one will steal your idea. Let your article "brew" in your mind for a few days or a week. Keep a file folder on hand during this percolating period for accumulating your facts, figures, and sketches.

If the article is to involve a theoretical discussion, don't make the mistake of relying solely on your own knowledge. Don't be afraid to do some research. Read articles—and books, if it will help—on your subject. Make notes during your research that you can refer to later. But don't plagiarize; your work MUST be your own. When you're finally ready to write, you'll very likely be armed with all the facts you'll need to present your ideas with competence, self-confidence, and accuracy.

Organizing Your Manuscript

There are no universal rules for preparing technical articles, but there are a number of ways by which you can increase their chances of ultimate sale. Most of them are

- Don't write without (1) research to back you and (2) an outline to guide you.
- Don't use cliches.
- Don't use unnecessary words and phrases.
- Don't use anyone's material but your own.

Few are those who can sit down and knock out a well organized article without first preparing an outline. Fewer still are those who can sell what they've written without an outline. The outline gives the final manuscript the basis for its organization. Once it has been prepared, the outline will help immeasurably to give continuity to

your text. The outline is as indispensable to most writers as a roadmap is to the tourist.

Just a word about cliches: There is probably nothing as boring to the reader as the frequent appearance of highly overworked words and phrases. "State-of-the-art," for example, is a very, very tired substitute for "technologically advanced." Steer clear of words like *saltmine, snore shelf,* and *feedbag;* these once-colorful expressions deserve a rest, and shouldn't be used except in satire.

Your manuscript should have a definite beginning, middle, and end. The beginning is the correct place to say something to catch the reader's interest or state an existing problem. The middle is the solution of the problem or suggested approaches to it. The end is the concluding thought of the author or his recommendation. The beginning may be a sentence, a paragraph, or —in some instances—a page. The conclusion is rarely more than a few lines. The body of the text, the meat, is the middle. It might help to prepare the middle in its entirety before writing the beginning and end. This may help to give you the necessary overview of the complete article, but it is a matter of individual preference.

When your article is complete, read through it as objectively as possible. Remove *everything* that is not essential to your text. Look for sentences opening with "It can be stated that . . . " and "Thus, it is safe to assume . . . " Phrases like these say little and carry the implication that you are unsure of your ground; they can usually be deleted without degrading the final manuscript.

When you've done all you can to improve the text's readability, put your article away for no less than two days (preferably a week or more), and push it from your mind. When you finally read it again, you'll be in a much better position to judge its real merit and make any corrections that might be indicated.

Presentation

I don't know of any publisher who will read a manuscript that has been handwritten on a brown paper sack. The old saw about not being able to judge a book by its cover may be a verisimilitude, but there are a lot of admen who would prefer to believe that the package sells the goods. And while a nicely "packaged" manuscript may not

sell your work for you, it will almost certainly assure that you get a reading.

Here are some of the requirements for creating an attractive "package," as applicable to *all* publishers:

Type your text double-spaced on white typewriter paper (20# bond), leaving 1½ inches of margin space on the left and no less than an inch on the right. Avoid typographical errors, typeovers, and messy corrections as much as possible so your work will have a professional appearance. In the upper corner of your first sheet, put your full name and address. Approximately centered on the sheet, and about a third of the distance from the top, place the title of your article. Directly below that, double-spaced, place your byline (name and call letters) as you want them to appear in the publication. Then triple-space and start your article (it should begin just above the halfway point on the sheet).

Number each page consecutively and place your last name or call letters on each sheet. This helps identify the author in case the pages get separated. Use a paperclip to hold the leaves together, but don't use staples. For some reason editors don't like to be bothered with removing them.

Mailing

Unless you are an established writer working regularly with one magazine, don't mail your manuscripts without including sufficient postage and a self-addressed envelope for its return in case of a rejection. But don't put the stamps on the self-addressed envelope; place them securely under the paperclip that binds your pages. If your article is retained for publication, the editor can keep the stamps and use them for some other purpose. The self-addressed envelope should be folded once and placed with your manuscript inside a heavy 9 x 12-inch manila mailing envelope. You may include a brief introductory letter to the editor along with your manuscript, although this is not necessary.

Editors are busy people. They write, rewrite, proof, and correct copy. They must read material from hundreds of sources. They must adhere to the rigid schedules associated with their work. Consequently, the time that elapses between your submittal and the editor's decision may be lengthy. The period may be as short as ten days or as long as a few months. But don't be discouraged; a long wait is usually a healthy sign. It could mean the editor likes your article but hasn't decided where or how best to exploit it. If the editor is totally disinterested in your submittal, you'll likely get it back in less than two weeks.

Payment

The pay rates are pretty well standardized, although there are variations according to individual circumstances. A beginning writer can expect from \$12 to \$15 per published page, depending on how much editing and rewriting is necessary, the extent of art preparation required, and other related factors. As a writer becomes better known, his rates will increase proportionately.

There are two types of payment policies in standard use; these are (1) on acceptance, and (2) on publication. 73 Magazine pays on acceptance; CQ pays on publication. (QST does not pay at all.) "On acceptance" means that when the editor has made a definite decision to use your manuscript, he (or she) will mail you a check. "On publication" means that your check will arrive after your article is in print. From the author's viewpoint, the 73 policy is better. I was spending money in August 1967 for an article that didn't get printed in 73 until January 1968. Suppose something had happened so that my article was not suitable for publication by January? The "payment on acceptance" policy protects the writer from that eventuality.

Ethics

Writing—even as a once-in-a-lifetime occurrence—carries a burden of ethical conduct. And a writer who expects to be successful to any degree must never for any reason step out of these ethical boundaries.

The first rule is one that has been touched upon before: Use your words and no one else's. Never copy a paragraph or even a line without identifying the matter with quotation marks and citing the source.

Rule two is to forget a manuscript once it has been mailed. If you mailed it to 73 Magazine, you must consider that manuscript as the *property of* 73 until you hear from the editor. You must *not ever* send a similar manuscript to another publisher unless you have the ***express written permission***

of both editors involved. If you're submitting material that has been published elsewhere, you are obligated to tell the editor where and when. In this way, the editor can seek a clearance from the first publisher if necessary, thereby avoiding the legal problems of a breached copyright.

The last rule is one of etiquette. Don't bug the editor once you've submitted a manuscript. Relax and wait it out. Remember, the longer the editor keeps your article, the better its chances for sale.

Now! Why not put some thought into the articles you're going to write? Turn your pet circuits and cute construction ideas into cash; it will take a great deal of the sting out of what could otherwise be a pretty expensive hobby!

. . . K6MVH

(Ed. Note) Ken has covered the subject very nicely in this article. I would like to add a couple of items. If you plan to write for 73, you would do well to read some of his past articles, as he is one of a few authors who needs little editing. Read articles and see the format, the abbreviations, and the type of material we use most. Type your photo captions and diagrams captions on a separate sheet at the end of the article. Don't label photos as figures. We may not use all photos. If you have relied on outside material for any of your article, list references for the benefit of the readers who want to build your project.

W1EMV

A 4E27 Grounded Grid Linear RF Amplifier

Howard M. Krawetz WA6WUI
654 Barnsley Way
Sunnyvale, Calif. 94087

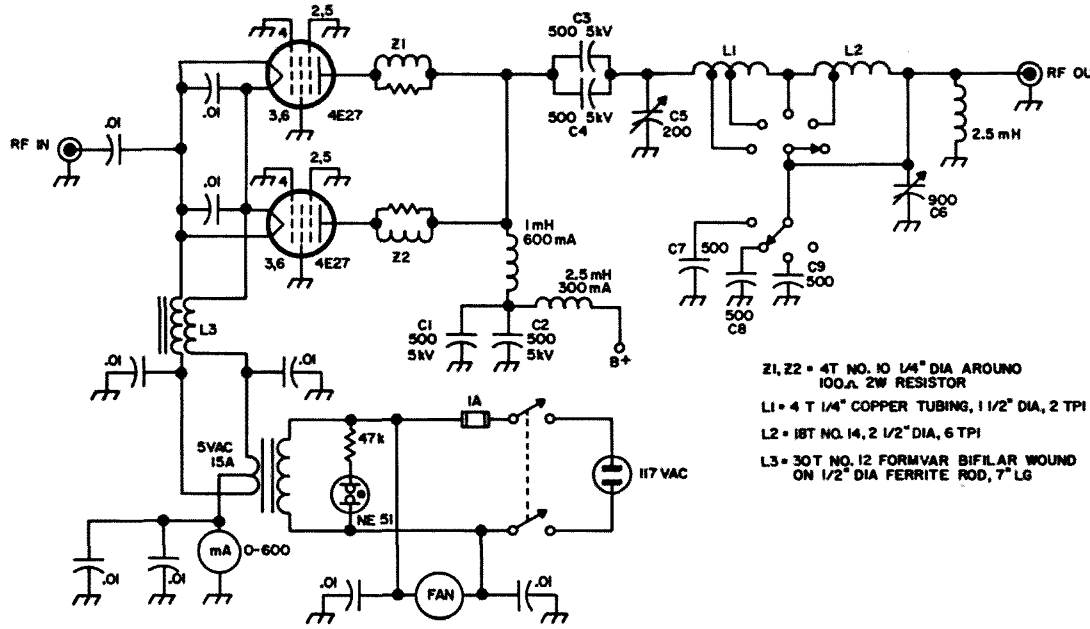


Fig. 1. *Linear amplifier schematic.*

The grounded grid rf amplifier described here covers a continuous frequency range of 3.0 MHz through 38 MHz in five steps. The circuit is straight forward, built around a pair of 4E27 tubes in parallel, with a pi-network output. If you prefer, 813 tubes may be substituted for the 4E27's without any electrical change in the circuitry. Mechanically you will have to change the plate caps for the 813's, the rest of the hardware remains the same.

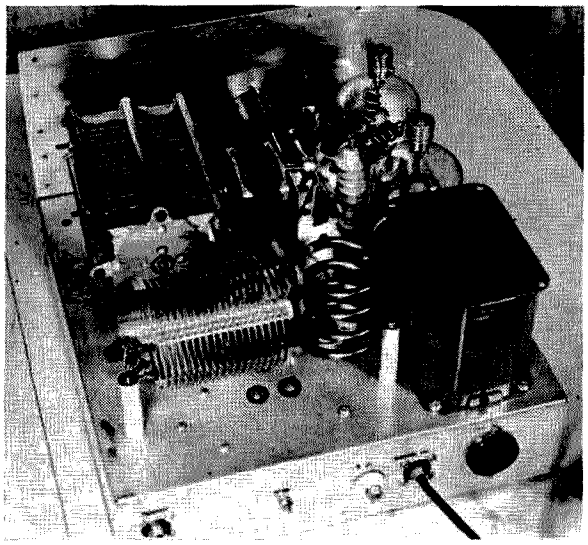
The amplifier is built on a 12 x 12 x 3 inch aluminum chassis. The total height of 8 inches is achieved by recessing the tubes 1 inch below the chassis. Drill plenty of ¼ inch vent holes in the chassis around the tube bases for proper heat dissipation. To conserve additional room, the coaxial connectors in the rear are recessed 1½ inch into the chassis.

Parts for this unit are available from surplus houses, wholesale or retail outlets, junk boxes or friends.

The amplifier schematic is shown in **Fig. 1.** Capacitors (C1, C2, C3, C4) are Centralab 850 type transmitting ceramics. After assembling the unit with the vacuum tubes in place, use a grid dip meter to tap the final tank. Set the plate tuning capacitor (C5) as follows when tapping tank coils L1 and L2:

Freq.	C5 setting	Turns in our circuit
3.5 MHz	90% of full mesh	18 turns on L2
7.0 MHz	50% of full mesh	8 turns on L2
14.0 MHz	20% of full mesh	1 turn on L2
21.0 MHz	20% of full mesh	4 turns on L1
28.0 MHz	15% of full mesh	1 turn on L1

The pi-network output capacitor (C6) is a three gang capacitor out of an old broadcast band radio. The three sections of capacitor (C6) are tied together in parallel. Three additional capacitors (C7, C8, C9), transmitting micas rated at 5000 volts test —2500 volts working, may be necessary for loading on the lower bands. The output



Notice short leads on suppressors. Keep the tank coils and variable capacitor close together. The filament transformer is shielded from rf by its case.

loading section is located below the chassis and shielded from the input circuits.

An ideal bifilar wound isolating choke (L3) is noted in **Fig. 1.** However, we could not obtain the recommended ferrite rod in the local stores so we substituted a ⅜ inch diameter ferrite rod 6 inches long. In fact we made three bifilar wound chokes with 30 turns each and tied them together in parallel to get the proper isolation and current carrying capacity.

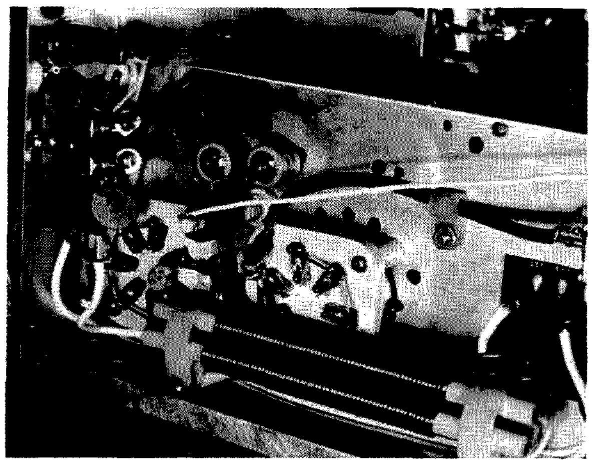
The meter is placed in the cathode circuit to keep the high B+ voltage off it. A good indication of how much total current is going through the tubes may be obtained from this meter.

It is suggested that the output power of the 4E27's in this circuit be limited as shown, although these ratings are considered to be conservative.

AM	200 watts per tube
CW-SSB	400 watts per tube

To check for parasitics (there shouldn't be any in this amplifier, but just in case) load the amplifier on 10 meters. After loading (into a dummy load of course) remove the excitation, then rotate the plate tuning capacitor (C5) 180°. There should be no variation in the cathode current without excitation. By now you may have noticed a residual current of 20 to 30 milliamperes in the cathode circuit. Don't worry about it, that's natural for this circuit. If, however, you do get a variation in current when rotating capacitor (C5) you will have to add a turn or two to the parasitic suppressor traps (Z1 and Z2).

There are several methods of tuning and loading this amplifier. You may tune by the



Note recessed tube sockets and three bifilar wound coils in parallel as close to the tube sockets and filament transformer as practical.

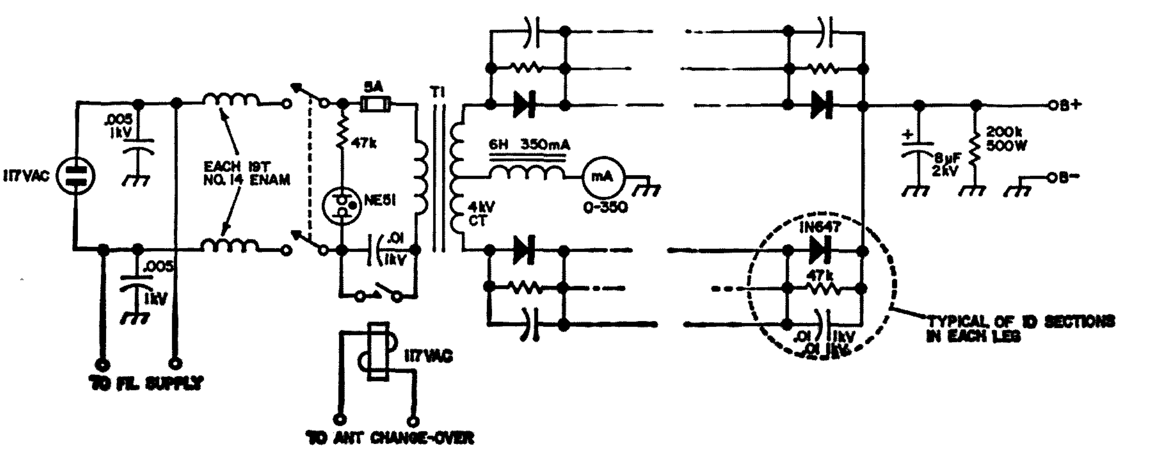
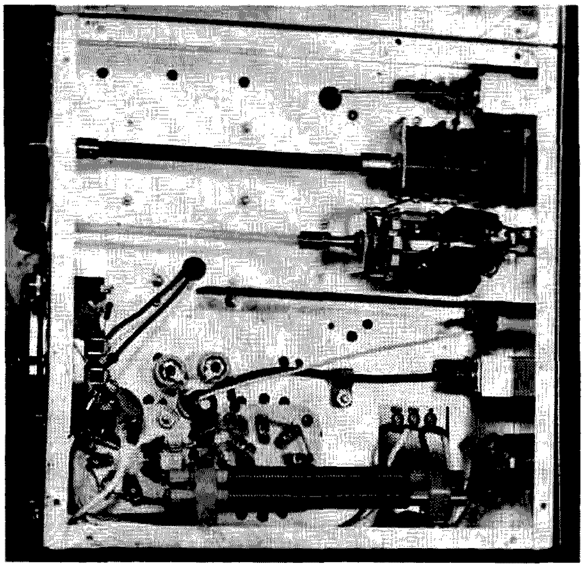


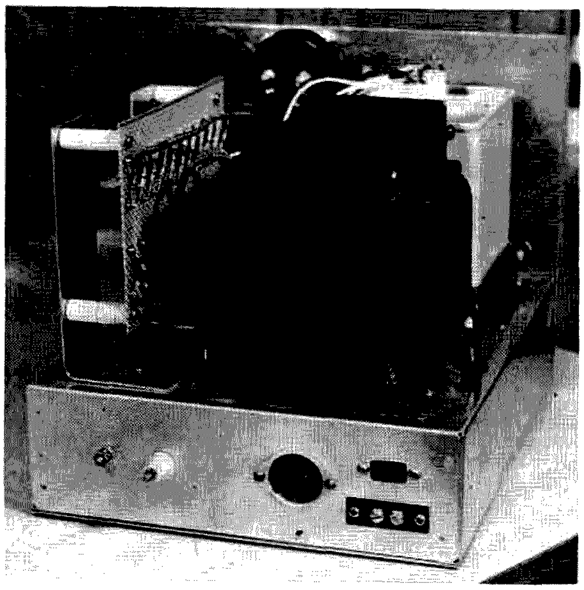
Fig. 2. Power supply schematic.



Bottom view. Notice the shield which isolates the output section from the rest of the circuit.

glow of the plates. However, I prefer to use an output indicator such as an SWR bridge or a monitor scope. Adjust the plate tuning capacitor (C5) until the output indicator reads maximum, then adjust the loading capacitor (C6) until the output indicator again reads maximum. Switch in additional capacity (C7, C8, C9) as required and retume (C6). The last step is then to readjust (C5) for maximum.

The 4E27's in this circuit amplify about 10 to 1 on 10 meters. So 100 watts driving power could get you 1000 watts to the plates, therefore, be careful not to burn up the tubes. Always tune up with reduced power.



Power supply. Nothing critical here at all.

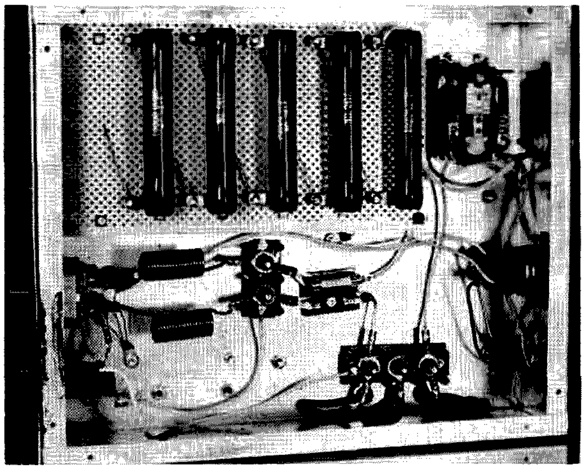
Power Supply

The power supply circuit for this 4E27 amplifier is illustrated in **Fig. 2.** A 10 x 12 x 3 inch chassis allows you plenty of room for all the power supply components.

The diode strings are mounted on terminals on a perforated epoxy glass board. The terminal mounting tools were a tack hammer and an almost blunt center punch.

The bleeder resistor is composed of ten 20 k resistors in series. Five watt resistors are adequate, but all I had was 50 watt resistors, so that's what I used. However, the larger resistors may be used in the future as a voltage divider for screen and suppressor grid voltages if you decide to change over to type AB_2 operation.

Operating the power supply is very simple, all you have is an on-off switch. The



The bottom of a power supply is the bottom of a power supply.

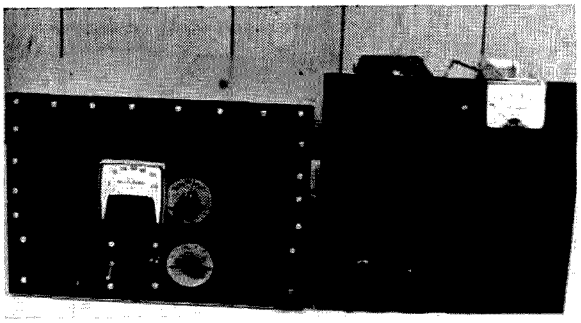
117 V ac relay makes and breaks the primary side of the power transformer. This eliminates any possibility of hash from the power supply while it's on stand-by.

A 300 mill dc ammeter in the cathode circuit of the power supply gives you an indication of how much B+ current you are drawing.

General Comments

If VOX operation is used, be sure to set the change over relay for a long delay so the unit will not change over on pauses in words. Rapid continuous keying of the power supply relay may cause an excessive load on the power supply.

I would like to thank Don Bristol, W6ZUI, for his assistance in developing this amplifier and for furnishing the major components



Amplifier and power supply

such as tubes, transformers, chokes and capacitors. One capacitor, the plate tuning capacitor (C5), was in a Bendix Frequency Standard aboard the Squalus submarine when it went down May 23, 1939 off the coast of Portsmouth, N.H. in 240 feet of salt water. Three months later when the submarine was pulled to the surface, much of the electronic gear was reclaimed including capacitor (C5).

Many thanks also to my good neighbor Marty Jacobson for the fine photos.

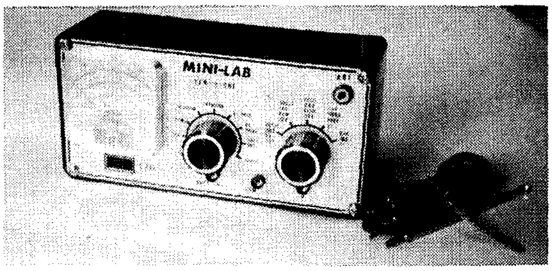
. . . WA6WUI

Split Frequency with the S-line

For a long while I've been plagued with having to manipulate my band switch on the 75S-3 whenever I wanted to work DX which was transmitting in the foreign phone band while I transmitted in the US phone band. A time was to come when the band switch was to give up the ghost, and it is a really difficult job to replace one.

I ordered a 8627.500 kHz crystal from International Crystal Company and inserted it into the holder for the crystal which is labeled 14.8. I now can tune 14.300 through to 14.100 with no trouble and no change of dial calibration. You can readily see what a labor-saving device this idea can be. Of course, the 32S-1 and 75S-3 are always operated transceive connected. I also find that it makes no difference if the 32S-1 is set on the 14.2 position or on the blank position which follows it. This is because when connected for transceive only the crystal in the receiver is used, despite the fact that you can split the equipment for independent operation when necessary.

. . . Gay Milius W4NJF



TEN-IN-ONE MINI-LAB

Here is a complete test laboratory all in one package! A modern miracle of electronics. This one unit contains an AC-DC Voltmeter: 50, 150, 500 volts; 0-500 mA; 10K, 100K, 1M ohms; resistance and capacitance substitution; 9 vdc battery supply; RF Signal generator 455 kHz (and up to 700 kHz); plus an audio generator at 400 Hz. You can service just about anything with this lab. You can signal trace and align receivers and trace audio systems, speech equipment, hi-fi and tape recorders. This is probably the single most useful piece of test equipment ever to come along.

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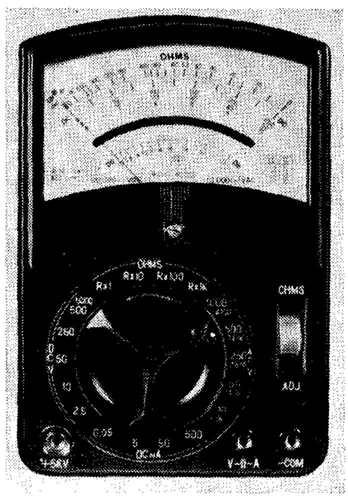

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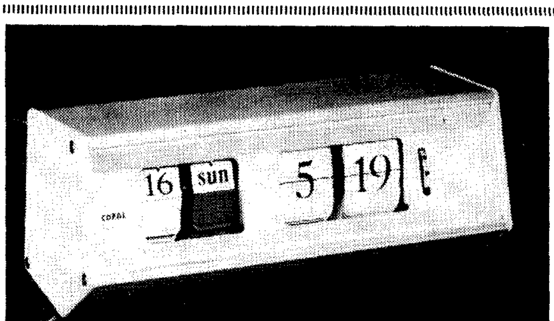

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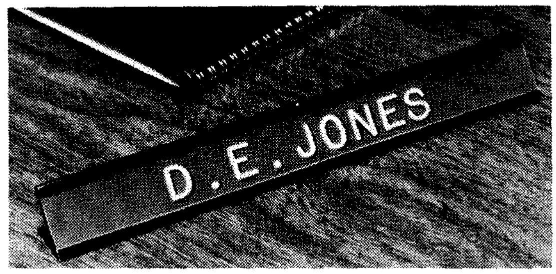

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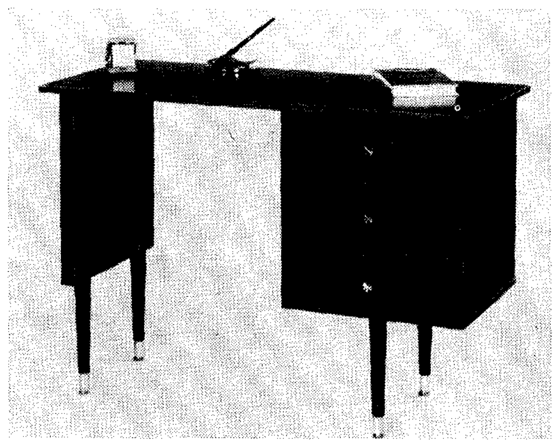

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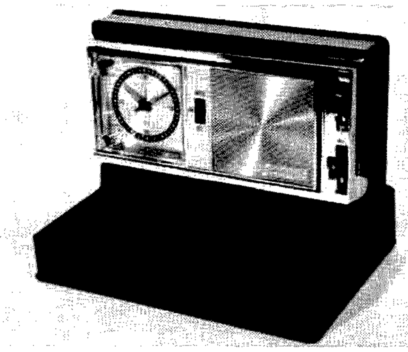

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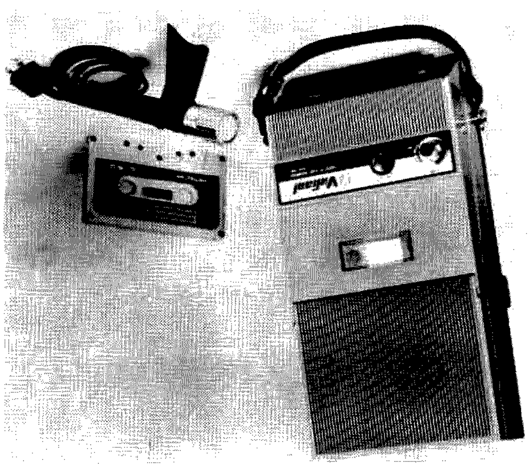

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54 Walter Street,
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QSL Display—The Easy Way

All hams want to wallpaper their walls with QSL cards and awards to show visitors, be they licensed or not, to show just how good an operator they are. But alas, the XYL always vetos such moves because of all the holes that will inevitably end up on the wall . . . and in most families, what the XYL says—goes! Here's an easy way to get around this problem, without spending a lot of time or money, and ending up with a really sharp QSL/certificate display.

The heart of the display is the use of *adhesive cloth picture hanging hooks and eyes.* The idea is that you *glue* your picture framed awards, etc. to the wall rather than nail them on. If at a later date you decide to remove the display, you just wet the hangers and the adhesive softens so that you can remove the frame . . . no holes, no nails! The hangers are available at any five and ten store. The ones I used are made by E. H. Tate Co. in Boston and go under the tradename of "DANDEE". They cost about 50¢ for six hooks and eyes; the instructions for both application and removal are on the back of the packages.

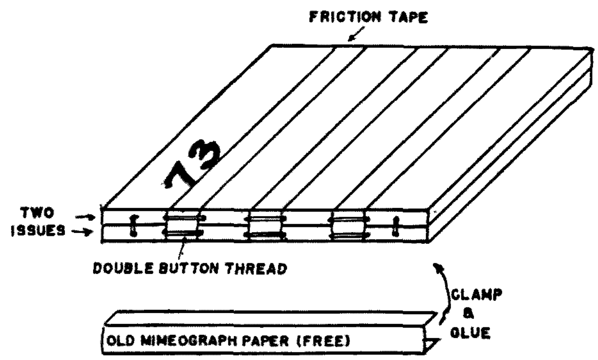
—this picture shows the materials needed for the QSL display

—the completed display really looks sharp—even if it doesn't contain a lot of DX cards!

Instead of mounting each QSL separately on the wall, I put a couple of dozen cards on a single piece of poster board or similar material, and used the hook and eyes to hang the whole board. This way a whole wall can be covered with cards with only a few sets of hangers. In order to mount the QSLs on the board, I used postage stamp hinges. These cost about two bits per thousand and are available at any hobby store. The advantage in using the hinges is that they can be removed from both the QSLs and the poster board without tearing. This is especially good for the fellow who wants to display his DX card collection but wants to be able to remove the cards easily for submission to WTW, etc.

To begin with, after you have all the hinges, hangers, etc., lay out your QSL card collection on the poster board. When you have a pleasing arrangement, you can start to fasten the cards to the board. I use four hinges, one at each corner and I find this is satisfactory. When the cards are all attached, glue on the eye as directed on the back of the hanger package and then glue on the hook. Now you can hang the board with your display. Do the same with the other boards until your display is completed. The certificates are attached in a similar fashion. Now stand back and listen to all the visitors comment on how good an operator they think you are!

. . . VE3BUE



Binding 73

Jim Kirk, W6DEG
1551 Church St.
San Francisco, Ca. 94131

In May, '68.73. I note author Tani C. Allen, WA4HRX, refers to my article on book binding in Dec. '66, 73. I have since made a great improvement that I think will prove useful to anyone following my system.

Instead of punching holes in the magazines, and mutilating them until I have a year's supply, I start the sewing process as soon as I receive the second issue. When I receive the 12th issue, I have a firm book ready to be mounted between covers. In the meantime I have a sturdy book for ready reference; one that grows with each month.

With 73's new format, it is super easy. I do not need to pull staples, or separate folios. I count the number of pages and make ice pick holes in the center of the magazine. Then I sew the two copies together. The next step is to place the "book" in a clamp, line it up, and glue a piece of absorbent (mimeograph) paper to the back. I use Le Page's mucilage in the convenient applicator bottle. I still use the re-inforcing tape, and bend the unused part over the cover.

I am now making books out of my four favorite magazines. CQ is not one of them, but 73 and QST are two of them. With QST, it is necessary to pull out the staples and separate the folios, of which there are at least 6 in each issue. This makes for more sewing, but you end up with a strong book.

Carole Allen W5NQQ
308 Karen Drive
Lafayette, La. 70501

The Care and Feeding of A Ham Club—II

Did you ever attend a meeting for the first time without even one person saying, "Nice to see you here," or "Be sure and come back next time?" Most of us have and can well remember thinking, "Well, I shouldn't have shown up in the first place." There's no percentage in being thin-skinned, but newcomers in a club should be given some kind of recognition.

Al Altomari, W8QWI, former president of the Lorain County, Ohio, Amateur Radio Association feels so strongly about this subject that he says "Treating the newcomer like an old timer" is their group's formula of success. An "Old Timer" in a club feels welcome from the time he enters the door until he leaves. Other members are quick to join him in conversation to find out what bands he's been working, etc. He may not be consciously aware of the fact that he's a member in good-standing, but he undoubtedly enjoys the friendship of the others. The same club may, without even realizing it, treat a new ham in its midst rather shabbily. If a fellow gets no greeting whatever and has to ask where to hang his coat, he couldn't be blamed for wondering if he made a mistake in showing up.

An easy way to avoid the possibility of losing a member after his first meeting is to appoint one, two, or a committee of "greeters." In fact, there may even be volunteers for this job since its usually more fun than serving on another committee—with the TVI boys, for instance. The greeters can keep their eyes peeled for a new face in the group. One or more will make a beeline for him at the first opportunity and extend the welcome of the club. If he already knows everyone, there's nothing much to do after the welcome, but if he's new in the community, introductions will be in order. This can be accomplished individually if you've got all night or done quickly if it's part of the evening program. Members of a group that isn't too large can stand one at a time giving his or her name and call letters. Hams have a definite advantage because many wear call letter badges, and new folks can use the "hamfest technique" by sneaking a look at the badge before calling someone by the wrong name.

Badges for all members of a club are a very good idea. They can be simple ones that you can get in a stationery store and just write in the name and call with a brush

A democratic club offers opportunity for members to discuss their problems and vote on important issues.

The RAMS (Radio Amateur Mobile Society) of Sacramento, California, says their formula of success is planning all activities to include the ham and his whole family. Officers who have worked for the club are (left to right—standing) K6ZFI, Bob; W6QHP, "Buck"; K6VYV, Steve; K6GUU, Bob. Kneeling left: WA6GIT, Dale and W6ZPX, Vern.

pen right on up to custom engraved club pins. Most engravers will do a nice job for you at a low bulk rate, if your secretary asks them. 73 sells club pins with the name of the club on one line and the member first name and call on the second for just $2 each in either red or black with white letters.

Since members often forget to wear their badges to meetings, thereby defeating the purpose of the badges, many clubs have the club secretary collect all badges at the end of the meeting and then hand them out at the beginning of the next meeting. Of course if the secretary is not dependable this system can fail too.

If the club has permanent badges for the regular members and makes up temporary ones for newcomers, it makes it simple for members to pay particular attention to the new hams.

Turn-about is fair play, so the new ham should also introduce himself to the club, mentioning where he lives, what kind of rig he has, etc. A bulletin editor who's on the ball will make notes and welcome the guy or gal in the next edition of the club paper.

A committee of ladies might want to drop by his QTH to say "hello" and invite his XYL to participate in club activities, too. Who knows, the ham who is the object of all the attention may turn out to be a real worker that you can't get along without. If, however, after all these expressions of good will and welcome, the prospective member doesn't darken the door again or rumors around that he had a "blah" time, write him off as a bad investment. As a member, you shouldn't feel at all guilty, for you'll know that the club did its very best to roll out the red carpet.

Getting the Show on the Road

When the president bangs the gavel and asks for attention, he takes the future of the club in his hands. The manner and speed with which he handles business directly affects attendance—the addition of new members, and the enthusiasm and loyalty of the old ones. For instance, if every session opens with a long, drawn-out business meeting that leaves little time for rag-chewing and refreshments, members may start making excuses about missing meetings. Ideally, the president should engineer a snappy opening and get the necessary business out of the way in a hurry. If the secretary can whip through the roll call, the treasurer won't need too much time unless he's handling more money than the U.S. Treasury. Although some groups like to hear the minutes of the last meeting read aloud, generally speaking, the faithful members already know what happened, and hearing the rehash is a real drag. If the club prints a newspaper or bulletin, the editor will probably welcome this material, and members who missed the last meeting can peruse developments at their own leisure.

If reports are in order from other chairmen regarding future functions, money-raising plans, TVI committee struggles, etc., these folks should also remember that they're sharing the business session with others. Since the president knows just how many reports are to be given, and what issues have to be settled, he might ask each chairman to limit his remarks to 3, 4, or as many minutes as required to cover the subject without wasting time.

A president must not only master timing but tact as well. Loaded questions and discussions may come up unexpectedly, and unless the leader knows how to handle the situation, he'll suddenly find the group squared off and feuding like the Hatfields and McCoys. For example, if someone stands up and says, "I don't think anyone under 25 should have a key to the club station," the president has to deal with the speaker, his supporters, the neutrals, and a dozen hot-tempered teen-agers. Unless touchy is-

Every club has to have a group of willing workers. Shown above are the officers of the Montgomery County (Illinois) AREC, Inc. together for a planning Pow-Wow.

sues such as this one have to be settled on the spot, it's a good idea to give answers a lot of thought. A committee can be appointed to study the question and work out a solution without insulting members on both sides.

Democratically, it's good for all important matters to come to a group vote; however, some clubs are organized by law giving final decisions to a board of trustees or directors. The latter is the case when a radio club is incorporated under state laws. Incidentally, incorporation has been recommended by legal counsel who point out that should some club activity result in a lawsuit, individual members would not be liable separately for the club's debts or troubles. A good way for a club of this type to solve a big problem is for the president's committee to report to the trustees or directors who can make their recommendations and then submit them to the club for its approval.

Established groups and their officers already know what unexpected wrinkles can arise and also how important it is to work out an acceptable solution. Newly-formed clubs will do well to copy the Boy Scouts' motto and "Be Prepared." Having a plan of action to put into effect when needed may head off real trouble.

After hearing reports and settling old and new business, the president can turn the spotlight on the program chairman and enjoy what follows. He's not completely out of the work harness, however, since adjourning the clambake is also his job. When the program is over and the discussion dies down, he closes the meeting officially. He can ask for a formal motion of adjournment, or if coffee and cookies are on the menu, he might call the host or hostesses away from the hot-plate to give serving instructions. At any rate, the session shouldn't just fade away with everyone thinking there may be something yet to come.

Technical Programs

Technical programs are to some radio clubs like salt and pepper on a fried egg—a little is a "must" but too much is tragic.

The club that is organized with the sole purpose of holding technical sessions featuring lectures and theory discussions doesn't have to worry about balancing their programs. They merely stick to the by-laws and attract hams who enjoy the same thing. But a club made up of Novices and old-timers, builders and non-builders, YLs and XYLs, has quite a chore pleasing everybody at least part of the time.

The best approach to the situation is to look the crowd over and see how many are interested in what, or even get a vote on it. If the entire membership prefers to tackle their ARRL handbooks at home with an each-for-himself spirit, you can plan accordingly. If several express a desire to see some instructional films or hear reviews of electronic trends, you'd better include some movies and speakers along these lines. It's very likely that a vote will go 50/50 and the program chairman will seem to be right where he started. Although it looks like nothing has been accomplished by a general vote, at least everyone will be aware that there's a demand for variety and will, perhaps, accept the "bitter with the sweet" without griping too much.

All right, so what do you do after some or all of the members have said "Let's have something educational." As program chairman, you may not feel like preparing a discourse on the most efficient method of demodulating a sideband signal, but who says you have to? First of all, look to the club itself for talent. If you've heard that the TV repairman on the back row is busy wiring voice booths in the high school's new foreign language training room, ask him to explain how electronics enables teachers to listen in on each student's progress. If Second-Row Joe is testing a homebrew quad on 10-15- and 20, see if he won't put his plans on the blackboard some evening.

Every club is loaded with specialists in various fields and some of them, surprisingly

enough, won't require too much arm-twisting before agreeing to take a program.

When local talent has been exhausted, start scouting the community and neighboring clubs, too. Many electronic industries and businesses are happy to provide films and slides on their products that are right up a ham's frequency. They may even send an employee with screen and projector. Who cares if the company sneaks in some advertising; the club will benefit from seeing how transformers are made, receivers designed, or vacuum tubes manufactured. Representatives are usually happy to answer questions, and members like to get information from the "horse's mouth."

Don't overlook films and speakers available for the asking from the Red Cross, Civil Defense groups, and also the military. Some organizations welcome chances to appear before the public. By checking with them for program material, you're doing both your club and an outside group a big favor.

Admittedly, if you're in or near a large city and industrial area, programs may be easier to come by. Groups in the grass roots have to scratch their heads, especially if they meet more than once a month. In the midwest, several small clubs may exist within a fifty mile radius. What's wrong with the program chairmen of these clubs picking an 80 meter frequency and swapping ideas once in a while. A speaker enjoyed by the Sangamon Valley Club might agree to go to another town. College campus groups in particular could benefit by a sharing plan since student chairmen can spare little time from books to search for program material.

Another little chore for the chairman may involve the matter of money. A club with a fat pocketbook can nail down about any kind of program because they can pay the price. If your treasury hovers on the empty mark, it's even more challenging to locate people who will perform for nothing. In this day and age that may seem impossible, but, thank heavens, there are still a few folks left who will. A club member who gives a demonstration or leads a discussion probably won't expect anything in return, but an outsider should be offered the price of gasoline, if nothing else.

When a speaker has been found, the chairman still can't fold his hands and forget the job. A few days ahead he should find out what stage props or equipment the speaker will need and arrange to have them handy. Since the visitor may not know anyone in the audience, a thoughtful chairman will break the pre-program ice early in the evening and make a few introductions to put him at ease.

Just keep in mind that if your speaker enjoys himself too, he might let you schedule him for a repeat performance next year. And counting c h i c k e n s before they're hatched is good business for a program chairman. . . . W5NQQ

Getting Your Higher Class License

Part V — Receivers

Operation of a ham station involves, basically, three major items of equipment—a transmitter, an antenna, and a receiver.

In previous sections of this study course for the new Advanced Class license examinations we have touched upon aspects of both the transmitter and the antenna (as reflected in the FCC study guide questions). Now it's time to turn our attention to the receiver.

The Commission's list of 51 suggested study questions contains six which deal directly with receiver operation, and they range from extremely detailed to extremely general. These questions (numbers are those assigned in the study list) are:

9. How can receiver sensitivity and selectivity be improved?
26. A superheterodyne receiver having an intermediate frequency of 455 kHz is to be adjusted to receive a signal on 3900 kHz. What frequencies can the high frequency oscillator be set to, to give a beat signal at the intermediate frequency?
33. Define the shape factor of a crystal lattice band-pass filter.
39. What functions does a variable-mu tube perform in an *rf* amplifier stage in a receiver?
41. How do noise limiters operate?
48. How does automatic gain control operate? When can it be used for SSB operation? CW operation?

Most receivers, these days, are superhets, and it's presumable that in the absence of any qualification to the contrary any question on the actual exam which deals with a receiver would assume that a superhet is involved.

However, non-superhets are still used for several special purposes. Therefore, although most of our discussion this month will concern the superhet, we must also cover non-superhet receiver types as well.

Following our usual practice of paraphrasing the FCC questions into more general questions covering (but not limited to) the same subject matter, let's re-frame the receiver portion of the study guide.

One of the first questions we ask must be, "How Does a Superhet Differ From Other Receivers" The answer to this will adequately distinguish between superhets and all others.

Any superhet, whether it be a four-transistor broadcast band squawker or an "ultimate" digital-tuning communications job, can be broken into four major portions as shown in **Fig. 1.** These offer us our remaining four questions.

Following the path any received signal must travel, we'll first ask, "How Does The Front End Operate?"

Superhet question number 2 (question number 3 of this installment) will then be, "What Does The *if* Strip Do?"

We'll follow this immediately with a look at filters in general—"Why Filter?", before our final theme, "How Does The Detector Section Work?"

Noise limiters, automatic gain control, and the like are all accomplished by the detector portions of most receivers—although AGC must also be involved with the *if* strip. Since we will be looking at the receiver as a functioning entity (except for the audio section, which we will ignore at this point), you may have a bit of difficulty relating the more detailed parts of the FCC study list to our questions.

To answer FCC question 9, you'll need to know about the front end and the *if* strip. Question 26 involves only the front end. Question 33 is handled in the discussion of filters. Question 39 involves both the front end and the *if* even though the question as stated by the Commission would involve only the front end. Question 41 involves only the detector circuits, while question 48 requires a knowledge of front end, *if*, and detector for an adequate reply.

Ready? Let's get to it.

How Does a Superhet Differ From Other Receivers? Unless you've worked your way up through a crystal set and a one-tube blooper (regenerative receiver to you young squirts) you may not have a real apprecia-

tion of the superhet. That is, of course, unless you've served your time with a Sixer or Twoer and the constant hiss of their superregen circuits.

The function of any receiver is to convert the *rf* energy transmitted upon some specific frequency into audio energy. The various types of receivers are all capable of performing this function. Some, however, perform it more capably than others.

All receivers can be compared with regard to their performance in three basic characteristics; sensitivity, selectivity, and stability. Sensitivity measures how weak a signal may be received, selectivity measures how well undesired signals are rejected, and stability measures the receiver's capability for staying on the desired signal without readjustment.

The lowly crystal set will perform the basic function of a receiver, provided that the *rf* energy carries amplitude modulation, but it ranks low in all three characteristics. Sensitivity is poor since all the audio energy produced must be supplied directly by the *rf* energy received. Selectivity is poor because only one or two tuned circuits are available to reject undesired stations. Stability is moderate, and is of little consequence since selectivity is so poor in the first place.

The next step up from the crystal set (not counting such modifications as the one-tube grid-leak detector, which is hardly ever encountered these days) is the regenerative receiver. This makes a single active element (tube or transistor) serve double duty as both an *rf* amplifier and a detector.

Sensitivity is much greater and selectivity is also improved because of positive feedback, which increases the sharpness of the tuned circuits. Stability, however, decreases; almost any movement near a regen will require retuning.

The regen has one capability lacking in the crystal set or other detector-only receivers: it can be adjusted to receive CW as well as AM by throwing the circuit into oscillation and mistuning it a kilocycle or so from the desired signal. The local oscillation and the incoming signal mix in the receiver to form an audible beat note.

The addition of *rf* amplifier stages between the antenna and the detector improved the performance of non-regen receivers and make them able to compete with regenerative circuits; this is the TRF (tuned radio frequency) receiver which was used to a

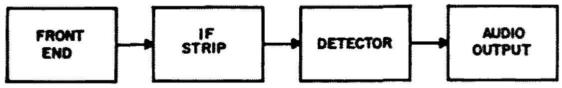


Fig. 1. Block diagram of any superhet receiver.

surprisingly great extent as recently as the 1940's.

The regenerative receiver offered highest sensitivity per circuit element, though, and experiments aimed at increasing its sensitivity resulted in the superregenerative circuit. This circuit actually oscillates, but its oscillation is interrupted or "quenched" at a supersonic frequency. As a result, you are able to hear the actual electron noise in the antenna wire. Any more sensitivity than this would be unusable anyway.

Unfortunately, both selectivity and stability on a superregen are poor. In addition, this receiver simultaneously performs as a low-powered transmitter, interfering with all other receivers in the area tuned to the same frequency.

The superhet is a combination of the TRF, the regenerative circuit, and the crystal set. The block diagram of Fig. 1 may be helpful here. The front end consists of any *rf* stages, plus a mixer which is similar to a regenerative receiver except that it is adjusted to produce an "intermediate frequency" output instead of an audible beat note. Some front ends use only a single tube or transistor as the mixer and call it a "converter," while other designs use separate oscillator and mixer elements. In these, the oscillator is called the "local oscillator" or "*hf* oscillator", and the mixer is known as the mixer.

The *if* strip is almost identical to a TRF receiver, except that it is permanently tuned to a single frequency and does not include a detector. The *if* frequency is usually relatively low; many circuits use a standard *if* of 455 kHz, but higher frequencies in the 1 to 10 MHz range are becoming more popular. In general, the lower the frequency the greater the gain and selectivity, but we'll go into this in more detail later.

The detector, for AM reception, is almost always a direct equivalent of the crystal set. For CW and SSB, product detectors (which are special types of mixers) are used.

The superhet combines the best features of all the types of receivers it combines, while escaping for the most part their problems. It offers excellent sensitivity, and if properly designed can have extreme selec-

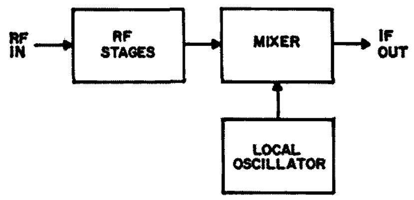


Fig. 2. Block diagram of superhet front end functions.

tivity and stability as well. For this reason, it has displaced all other designs as the "standard" receiver circuit—unless factors such as simplicity or economy happen to outweigh performance requirements in some special application such as the Sixer or Twoer!

How Does The Front End Operate? The "front end" of a superhet is the key to the entire receiver, and its operation contributes most noticeably to the operation of the receiver as a whole. **Fig. 2** is a block diagram of a typical "front end"; not all superhets include separate tubes for each block of **Fig. 2.** but all the functions are performed.

The basic idea behind the superhet is that of "beating" or mixing two radio frequencies in order to produce a sum or difference frequency, which carries all the modulation of both original frequencies. If one of the two original frequencies is the desired signal, and if the other is unmodulated and at a fixed distance in the spectrum from the first, then the difference frequency will carry the modulation of the desired signal, but will always be at a fixed frequency.

This fixed or "intermediate" frequency is equal to the separation between the frequency of the desired signal and that of the unmodulated second signal.

The functions shown in **Fig. 2** break down as follows: The *rf* Stages amplify the desired signal, thus increasing receiver sensitivity, and provide some selectivity as well. The Local Oscillator provides the unmodulated second signal; this oscillator is always tuned to a frequency which is separated from that of the desired signal by the *if* frequency, but may at times be tuned to a higher frequency than the signal (high-side injection) and at other times to a lower frequency than the signal (low-side injection). The Mixer combines the two *rf* signals to produce both the sum and difference frequencies; a tuned circuit in the Mixer's output portion selects only the difference frequency for passage to the *if* strip.

Since the local oscillator may operate on either the high side or the low side of the incoming signal, it follows that a *single* setting of the oscillator frequency permits reception of incoming signals at *two* different frequencies. One of these is above the oscillator frequency by the amount of the *if;* for it, the oscillator provides low-side injection. The other is below the oscillator frequency by the amount of the *if,* where the oscillator provides high-side injection.

One of these two frequencies represents the desired signal. The other represents an undesired response called the "image", and is one of the major disadvantages of the superhet receiver. The image is always separated from the desired signal by twice the intermediate frequency: If the *if* is low to provide gain and selectivity easily, the image will be close to the desired signal. If the *if* is made higher to move the image away from the desired response (the more separated the two signals are, the more readily the image can be rejected by the tuned circuits in the *rf* stages), both gain and selectivity suffer.

A standard *if* frequency is 455 kHz. In a receiver using this *if,* the local oscillator is always tuned 455 kHz away from the frequency to be received, and the images are always 910 kHz away from the desired responses.

Most BCB receivers operate with high-side injection to overcome tracking problems; this means that image response can be observed easily if you have a high-powered BC station operating above 1410 kHz near you. Simply tune to the *low* end of the band. At 500 kHz on the dial, a strong 1410-kHz signal will come through. At 690 kHz on the dial, powerful 1600-kHz signals can be heard. This is normal for a superhet.

To receive an incoming signal at 7.2 MHz with a 455-kHz *if,* you could set the local oscillator to either 6.745 MHz for low-side injection (with image at 6.290 MHz) or 7.655 MHz for high-side injection (with image at 8.110 MHz).

Both image frequencies are fairly close to the desired frequency in the previous example. By the time you move the operating frequency up to 10 meters or above, the image response may be just as strong as that to the desired signal. For this reason,

many receivers use a higher *if*. If a high *if* is used for image control, and then converted to a lower *if* for its advantages, the receiver is known as a "double conversion" receiver. Incidentally, any receiver used with an outboard converter (as for VHF operation) is double conversion, since the outboard converter effectively becomes the receiver's front end.

If the *if* is properly chosen, the image situation can be used to advantage. For instance, to receive signals on either 40 or 80 meters, an *if* of 1750 kHz can be chosen. This puts the images 3.5 MHz away from the desired response, and if the oscillator frequency is selected to give high-side injection on 80 and low-side on 40, then one response will cover 3.5 to 4.0 MHz while the other response gets 7.0 to 7.5 MHz. No bandswitch is necessary!

Similar reasoning led to the choice of 9 MHz as the "standard" frequency for SSB sideband generation. Use of a 5-MHz conversion oscillator permitted output on either 80 or 20 meters without a bandswitch, by using "image" response techniques.

The local oscillator is important to the superhet for a number of reasons. Its frequency stability, for example, determines the stability of the entire receiver, because if the local oscillator drifts the *if* produced by a stable signal will drift out of the *if*-strip passband. It must also be relatively low in noise modulation, since any modulation present on it will appear in the output together with that of the desired signal.

The mixer must convert frequencies properly, but in the HF range its characteristics are not particularly important. At VHF, mixers must have low noise if full receiver sensitivity is to be used. At any frequency, they must be overload-resistant to avoid interference, but most common circuits resist overload to an acceptable extent.

The *rf* stages may be omitted in inexpensive receivers; in this case their key function is taken over by the mixer's tuned input circuit. This function is to select the desired frequency and reject as much as possible of the image response.

If *rf* stages are present, they add selectivity so far as images and interference by cross-modulation and mixer overload are concerned, but they have little effect upon adjacent-signal selectivity. That occurs in the *if* strip.

One major effect of the *rf* stages is to determine receiver sensitivity. Sensitivity is not the same as gain; sensitivity measures the weakest signal which can be received while gain measures the amount of amplification available through the receiver. A high-gain receiver without an *rf* stage and with a noisy mixer can easily fill the room with amplified noise, but it won't get many weak signals. A unit having lower gain, but with adequate *rf* amplification to overcome any mixer noise, may appear to be dead—until you tune across a "down in the mud" signal and copy it clearly.

Because of the difference between sensitivity and gain, simply counting the number of *rf* stages isn't much of a guide. A single, good *rf* stage is better than three which contribute little but noise.

If a receiver will show an increase in noise when an antenna is connected to it, its sensitivity is probably already at the usable limit. If no change can be detected, though, addition of another *rf* stage may prove profitable in increasing (and thus improving) sensitivity. This may be done by adding a preselector, outboard. A "preselector" is nothing but an outboard *rf* stage (or stages).

Note that *sensitivity* can be affected only by the *rf* stages; gain, on the other hand, can be increased in the *if* strip, or even after the audio is recovered from the signal. If no *rf* stage is present, it may be possible to modify the mixer's operation to improve sensitivity—but addition of a preselector is a far better solution.

What Does The if Strip Do? The front end selects any desired signal frequency within its operating range and converts it to a single fixed intermediate frequency. The *if* strip, then, accepts this intermediate frequency signal and amplifies it to a level suitable for the detector circuits. At the same time, unwanted signals at adjacent frequencies are rejected.

The *if* strip thus serves two purposes of equal importance. It provides gain for the selected signal—not to be confused with sensitivity—and also provides the major part of the receiver's selectivity.

Fig. 3 shows the arrangement of a typical 2-stage *if* strip. Any specific receiver may have more or less stages of *if* than this; the minimum is a single transformer, which provides only selectivity and no gain, while the maximum normally encountered is three.

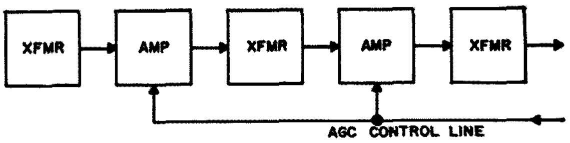


Fig. 3. Block diagram of two stage if strip (typical).

The amplifier blocks in **Fig. 3** may be occupied by tubes, transistors, or any other active device (such as field-effect transistors, etc.) which can provide gain. In general, the amplifiers provide the gain while the transformers provide the selectivity.

Normally, most receivers incorporate automatic gain control for AM signals at least. This is a feedback action which employs a dc voltage developed in the detector circuit to control the gain of the *if* strip, and frequently the gain of the *rf* stages as well. The result is that the receiver operates at maximum gain with weak signals (which develop little AGC voltage), and gain is automatically reduced by stronger signals.

AGC circuits are many and varied; we'll look at the means by which the AGC voltage is developed a little later, and that's where most of the variety occurs. In the *if* strip, the AGC acts only to reduce amplifier gain.

With tube-type circuits this is most often accomplished by use of "variable-mu" tubes. A variable-mu tube's grid is built with a graded grid-wire spacing. Some of the grid wires are close together while others are farther apart from each other. This permits a wider range of gain-control bias voltage to be applied, since the close-spaced parts of the grid reach cutoff with low bias values but a large bias voltage is necessary to cut off the widely spaced portions. Where a "sharp cutoff" tube may go from full conduction to full cutoff with a 10-volt swing of grid voltage, a "variable-mu" (sometimes called "remote cutoff") tube may require a 50-volt or greater swing. The variable-mu tube also acts as a linear amplifier over a greater range of control voltages. Thus, this tube acts as an electronically controlled gain controller.

Although **Fig. 3** shows the AGC voltage applied to both amplifiers, in many receivers only a portion (or even none at all) of the AGC voltage is applied to the final *if* amplifier stage. The purpose of this is to concentrate the control in the earlier stages and thus prevent any possible signal overload within the *if* strip. Having the final *if* tube operate at maximum gain at all times assures that even signals which are only moderate in strength will develop adequate control voltage in the AGC circuit.

When AGC is applied to the *rf* stages, it is often left off of the first *rf* or "antenna" stage (or only partially applied, through a voltage divider network). The reason for this is a bit different. For maximum sensitivity the first *rf* stage should always operate at maximum gain. Any reduction of gain in this stage reduces overall receiver sensitivity. Sometimes, though, partial application of AGC to the first stage is necessary in order to provide adequate control range.

While **Fig. 3** shows transformers as the coupling elements between input, amplifier stages, and output, a number of other devices may also be encountered. Transformers are, however, the most frequently used. They serve two purposes. The most obvious is that of coupling two stages together. The more important, though, from a performance standpoint, is to provide the major part of the receiver's selectivity. In fact, some designs have used cascaded transformers, with 2 to 4 transformers between each amplifier stage, in order to increase selectivity. The number and quality of transformers used is affected by many factors. If, for instance, an auxiliary filter is used, fewer transformers are required since the filter provides selectivity enough, alone.

Why Filter? In examining the previous question, we noted that the transformers in the *if* strip (**Fig. 3**) provide the major part of a receiver's selectivity. If this is the case, why should any receiver require a filter?

In the first place, a receiver actually *is* a filter of sorts if it selects only the desired signal from the mass of signals available to it.

And the transformers in an ordinary *if* strip permit some frequencies to pass while rejecting others, which is the function of any filter. This is accomplished by means of the selectivity inherent in any tuned circuit. Each transformer contains from 1 to 3 tuned circuits (depending upon the transformer design) and most contain 2.

The total number of tuned circuits in the *if* strip thus depends upon the number of transformers. But the *effect* of these tuned circuits increases exponentially. That is, if a single transformer has a certain amount of selectivity, adding another transformer to

double the number of tuned circuits will roughly double the selectivity. Adding just one more transformer will approximately double it again, so that 3 transformers provide 4 times the selectivity of 1. This is the reason that receivers using several transformers between each *if* amplifier stage have been designed; the transformers improve selectivity, but the gain obtainable by adding more tubes just wasn't needed.

With any practical number of transformers. though, you eventually reach a limit of selectivity. And unfortunately, at the *if* frequencies most often used, this limit is still a bit broad for today's crowded spectrum—and impossible for SSB.

The selectivity provided by transformers depends upon the frequency-rejection characteristics of their tuned circuits. These, in turn, are composed of inductors and capacitors. It happens that inductors and capacitors can be combined in other types of circuits—and these circuits are of the kind generlly known as filters.

In the transformer, normally only two tuned circuits are involved, and each of these affects the operation of the other. Since the transformer also performs the function of coupling two stages together, the circuits are also affected by the characteristics of the stage supplying the signal and the loading of the stage to which the signal is supplied.

In the filter, however, the only function to be performed is that of frequency selection. The design of a filter circuit involves choice of inductor and capacitor values so that no one component has unwanted effects upon the total filter operation. Since the functions of frequency selection and of stage coupling are separated, the selectivity of a filter can be made much greater than that of a simple transformer.

However, when a filter is composed of only inductors and capacitors, a limit is still reached; to achieve still greater selectivity, *perfect* resistors and capacitors would be necessary, and these don't exist.

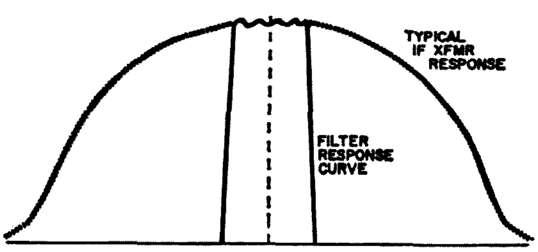


Fig. 4. Effect of filter on improving if selectivity.

This is the point at which crystal and "mechanical" filters enter the picture. Actually, all non-electrical filters which are used to provide selectivity are mechanical in their operation, but the term "mechanical filter" has come to mean a specific type of filter which depends upon characteristics of a machined rod.

A crystal filter achieves performance superior to that of an L-C filter for precisely the same reason that a crystal oscillator is more stable than a VFO—its characteristics can be more precisely controlled.

A quartz crystal, if ground to some rather critical dimensions and in the proper shape, is mechanically resonant at several specific frequencies, and is also mechaniclly "anti-resonant" at at least one other frequency which is usually very close to one of the resonant frequencies. At the resonant frequencies, any vibration applied to one side of the crystal can pass through almost unchecked. At the anti-resonant frequency, the crystal offers a very high impedance to any signal transfer through it. This characteristic is similar to the series and parallel resonances of a tuned circuit, but since it is mechanical rather than electrical in origin the effect is much more pronounced—in radio terms, the Q is much higher.

A single quartz crystal can serve as a filter for any of its resonant frequencies if electrodes are held in contact with its surface so that the vibration can be induced electrically and can in turn reconvert the signal to electrical form. Such a filter has been a key part of CW receivers for many years, but its selectivity is far too great for most phone use. A good single-crystal filter can have a passband as narrow as 50 cycles at the half-power points, and only a few hundred cycles wide at the skirts of the response curve.

Today's crystal filters used in SSB generators and selectable sideband receivers, though, use several crystals and match the resonant frequencies of some with the anti-resonant frequenceis of others to produce selectivity curves which are like that shown in Fig. 4. The passband (top) is essentially flat, so that the desired signal all comes through, while the rejection cuts in almost instantly at the edge of the passband to provide extreme rejection of all except the desired signal.

By contrast, the typical transformer response is many times as wide at the skirt

(base) of the response curve as it is at the top.

The performance of any filter is measured by its "shape factor". Shape factor is the ratio of the bandwidth which the filter will pass at two specified power levels. Unless both power levels are specified, the shape factor has no meaning. General usage appears to be that the 6-db and 60-db passband widths are compared, but some authorities prefer the 3-db points for the upper level.

What this means is simply that the bandwidth a filter will pass depends upon how much rejection you require. If you consider *any* rejection enough, then even a 10% drop in signal level would be "rejection" of the signal. This, though, would permit an unwanted signal which was only 10% stronger than the desired signal to come through with the same strength.

The "passband" we usually think of at the top of a filter's curve is that from the 6-db points. These are the two points, one at either either side of the filter's center frequency, at which power transfer through the filter has dropped to ¼ of its maximum level. A 3-db reduction in power is the smallest we can detect by ear; a 6-db reduction amounts to cutting the signal voltage in half.

However, a 6-db rejection of a signal which is producing twice as much signal voltage as our desired signal will only make the undesired signal the same strength as the one we want. This shows that, in order to accomplish effective "rejection" of undesired signals, we must have much more than 6 db rejection.

We must, in fact, have whatever rejection it takes to *first* cut the undesired signal down to the same level as the desired one, and *then* push that undesired signal on down to a level however far we like *below* the desired one

In practice, a thousand-to-one ratio is usually considered good enough. That is, an undesired signal is effectively rejected if it can be reduced to one-one-thousandth the level of the desired one. And it's seldom that an undesired signal will be more than 1000 times as strong as the signal we want in the first place.

If the undesired signal *is* 1000 times as strong as the one we want, and we want to cut it down to I/1000 the strength of our desired signal, then the total reduction we must make in its strength is one million times. That's 1000 times to get it down to the same level, and another 1000 times to get it only a thousandth as strong as that level.

In terms of decibels, that's 60 db of power loss. While in many cases far less than 60 db of rejection is necessary, this represents a severe case which is still quite possible to meet in practice, and so the general usuage calls for use of the 60-db point as the wider passband in calculation of shape factor.

A typical shape factor for a receiver without a filter (except for its transformers) might be 50. This would mean that the 60-db bandwith is 50 times as wide as the 6-db figure. If "bandwidth" is quoted as 10 kHz at 6 db, then a band 500 kHz wide would have less than 60 db rejection. The 60-db rejection would not be present within this much larger passband; you would naturally consider such selectivity poor since strong signals several hundred kHz away from the weak one you're trying to get would appear stronger than the weak one.

Extremely good filters, however, such as the mechanical types, may have shape factors as good as 1.8. If the 6-db passband of such a filter is 10 kHz, then the passband at the 60-db rejection points would be only 18 kHz. This means that an interferring signal would have to be within 18 kHz of the desired signal in order to escape the full rejection. While the 6-db passbands in both cases were the same, the effect in operation is quite different. This is why filter effectiveness is measured by "shape factor". Most good filters have a shape factor smaller than 3; no device can have a shape factor smaller than 1, and even 1 itself is impossible in practice.

How Does The Detector Section Work? The purpose of the entire receiver up to the detector section is merely to select a single signal out of all that are floating round and amplify it up to usuable strength for the detector. The detector itself does the major job, of converting *rf* to audio energy.

As we've already seen, in simple receivers only the detector section is present.

The detector itself operates upon a mixing principle. A product detector requires signals from a beat-frequency oscillator to mix with the *if* strip's output, while a diode detector for AM uses the carrier portion of the incoming signal to mix with the side-

bands. We've already examined this process in other parts of this series. What we'll examine now, then, are the *other* functions accomplished in this part of a typical superhet.

We've already met AGC in the *if* strip and learned that a control voltage determines the gain of the amplifiers. This control voltage is developed in the detector section.

Communications receivers must frequently operate in the presence of strong impluse "noise" such as that produced by automobile ignition systems. This noise can be eliminated or at least greatly reduced, and this action too is done in the detector section.

Let's look at AGC first. And to keep things simple, let's restrict the operation to AM with a diode detector. After we see how the system works, then we'll examine AGC and SSB/CW.

When we're receiving AM, the incoming signal has a carrier which was essentially of constant strength when it left the transmitter. Fading and other transmission effects may cause its strength to change en route to the receiver, but we know that it was originally constant over a period of several tenths of a second.

In the process of mixing the carrier and its sidebands to recover the audio information, the detector produces a dc voltage which is proportional to the strength of the carrier. We can pass this dc voltage (which has the audio superimposed upon it) through a low-pass filter to eliminate the audio, and we have a voltage which indicates the signal strength.

We *could* apply this voltage directly to the *if* and *rf* amplifiers as AGC control voltage, and some receiver designs do. The disadvantage of this approach is that *any* signal will then cut back the gain of the amplifier stages, even if the signal is almost unreadably weak.

To avoid this disadvantage, most designs used "delayed" AGC. The delay is not in time, but in voltage; until the voltage produced by the detector is greater than some "threshold" level, no AGC control voltage is applied and the amplifier stages run wide open. After a signal is strong enough to produce a detector voltage above the threshold point, AGC is applied to reduce gain.

If you recall the exploration of "feedback" we made a couple of installments back, you may recognize our old friend feedback at work again here. An AGC system is, in effect, an amplifier with negative feedback put into it in such a manner that the *gain* of the amplifier is reduced by strong signals, but signal voltages themselves are kept out of the feedback path.

Notice that the only function of the dc voltage coming out of the AM detector is to give us a feedback signal which is proportional to the actual *rf* signal strength. If we can get such a feedback signal from any other source, the AM detector isn't necessary. When we're receiving CW or SSB, neither of which uses the AM detector, we obtain the feedback signal by taking a part of the audio itself and rectivying it. After rectifying it, we filter off the remaining audio hash, and presto! we have our desired AGC control signal.

When receiving SSB, or CW, we add a few extras to the system. For instance, if signal strength increases suddenly we want the AGC system to react rapidly. This happens at the beginning of each "dit" or "dah" during CW reception, or with each syllable when listening to SSB.

When no signal is coming in, we want gain to be maximum. However we don't want the gain to go up rapidly between "dits" or "dahs" in CW, or between syllables in SSB, because if it did we would be listening to a signal apparently buried in noise. The noise would be the normal background, but the receiver would have much more gain then than when signals were present.

For this reason, we want the gain to decrease rapidly when a signal appears, but to increase relatively slowly when the signal goes away. This will hold down background mud while preventing unpleasant "thumps" and bangs".

AGC systems for use with CW and SSB include this "fast attack slow decay" chracteristic as a part of their design. It is normally switched out when AM operation is chosen. **Fig. 5** shows one way of achieving this kind of action.

What about noise limiting?

Like AGC, noise limiters operate with a control signal which is usually derived from the source as the AGC control signal. This signal indicates average level at any instant.

Any modulation or audio on the signal is in the form of variations above and below the average level, but these are limited in

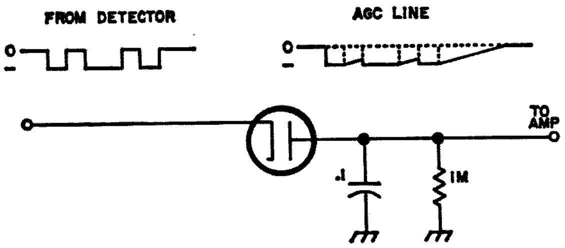


Fig. 5. Diode in series with AGC line provides fast-attack slow-decay action for use with SSB and CW signals. Waveforms produced by CW character "R" illustrate the action. When detector voltage goes negative at start of each code element, capacitor voltage follows almost instantly. When detector voltage goes positive, diode cuts off and only discharge path for capacitor is the high-value resistor shunting it. This permits AGC control voltage to rise toward ground level, but much more slowly. Receiver gain is restored eventually, but not before next code element arrives. In pauses between words or sentences, however, full gain is available.

the amount of variation by the percentage of modulation on the original signal, and in the speed of their variation by the upper-frequency limit imposed on the audio before transmission.

Impulse noise, on the other hand, is unaffected by either of these limits. It may be—and usually is—much stronger than the signal, and may swing much more rapidly. Since it does differ from the modulation on our desired signal in both these key characteristics, either characteristic may be used to distinguish between signal modulation and impluse noise in order to reject the noise and pass only the desired modulation.

If amplitude is the characteristic chosen to operate the rejection circuit, the resulting circuit may be called a "clipper" or a "limiter". If the speed of variation is the characteristic chosen to distinguish, the circuit may be called a "silencer". These labels are not strict, however. For example, the "rate of change" limiter circuit originally popularized in these pages some 7 years ago operates, as its name implies, upon the rate of change in signal, yet was termed a limiter. The Lamb noise silencer, similarly, operates upon amplitude of the signal yet is called a silencer.

Amplitude-limiting circuits, or clippers, operate by setting an arbitrary limit for audio output and restricting *all* audio to that limit or less. An impulse noise pulse is permitted to reach the limit, but not to exceed it. The limit is derived from the dc voltage, which in turn is derived from signal strength, so that the limit always bears a fixed relationship to the average signal strength. Normally, the limit is set at two times average signal strength. That is, the audio is permitted to rise to a level twice as great as the zero-audio carrier-only voltage. This permits reception of 100-percent modulated signals without distortion, but cuts off noise pulses at the 100-percent-modulation level.

This approach works primarily because noise pulses are so brief compared to the desired audio signals, and cannot mask the desired audio unless they are many times stronger—which, in fact, they normally are. By simply cutting the noise back to the same level as the signal, the signal is given a fighting chance.

Rate-of-change devices operate differently. The control voltage in a rate-of-change device is derived from the audio signal rather than from the carrier, and is filtered through a resistor-capacitor network which permits the control voltage to follow the audio signal level at frequencies below about 3 kHz or so. This is unlike the filtering for clippers or for AGC, where no audio is permitted to remain on the control-voltage line.

The audio is applied to one side of a switching diode and the control voltage

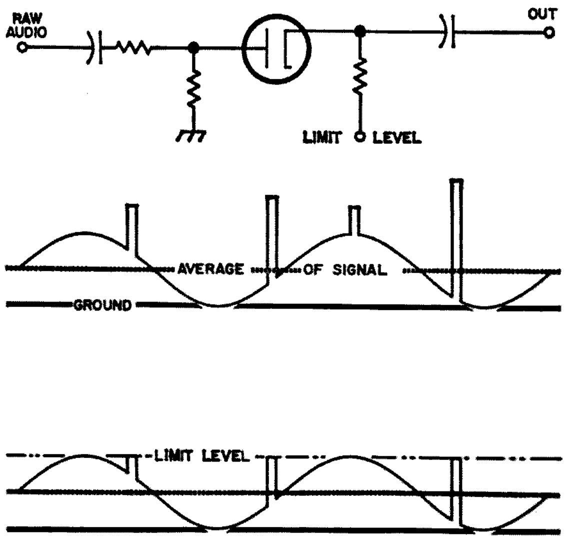


Fig. 6. Clipping type limiter uses diode as switching clamp to prevent signal voltage from rising above limit level. No action is taken upon noise pulses which fail to reach limit level. While "stumps" of noise pulses remain, their effect is far less than that of the original pulses.

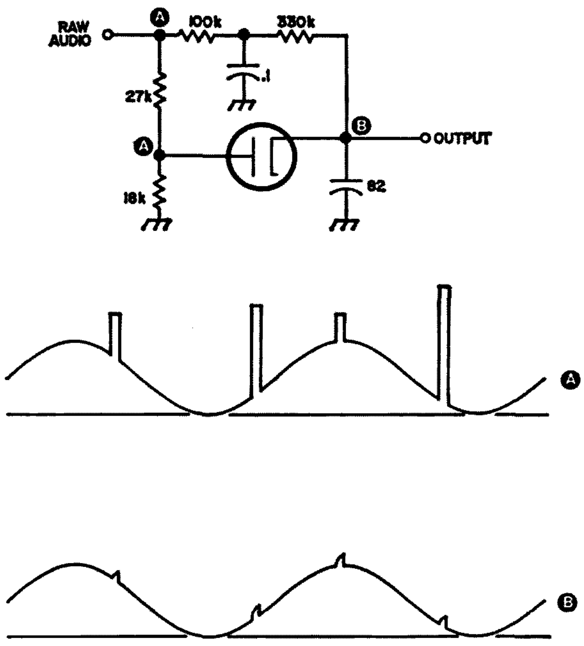


Fig. 7. Rate-of-change type of limiter uses diode switch to open audio path whenever noise pulse is present. Stumps as well as peaks of noise pulses are removed. Major difference in operation from Fig. 7 is characteristic of control-voltage filter, see text.

to the other side. Polarity of the diode and relative strengths of audio and control voltage are chosen so that the diode normally conducts, permitting the audio to go straight through it. That is, the audio voltage is normally slightly less than the control voltage level and the diode is connected in such a way that under this condition it is conducting.

When a rapid-rise noise pulse arrives, the audio voltage goes up sharply but the filtered control voltage cannot, because the filter limits its frequency response to about 3 kHz. The diode is then reverse-biased and turns "off", blocking the path from input to output of the circuit. Audio output is maintained at the same level by the control voltage filter for the duration of the pulse. When the pulse disappears, The control voltage level is again higher than the audio level and the diode turns "on" again. This action effectively punches the noise pulse *out* of the signal.

Figs. 6 and **7** show how these circuits operate. **Fig. 6** shows a typical half-wave clipper circuit together with the waveforms at appropriate points in the circuit. A full-wave clipper consists of two such circuits back to back so that both sides of the incoming signal are clipped; in many detector circuits the second clipper is unnecessary since the detector diode itself is an effective half-wave clipper in one direction.

Fig. 7 shows a typical rate-of-change limiter circuit together with its key waveforms. The same input signal is assumed for both **Fig. 6** and **Fig. 7**, so that the outputs may be directly compared.

Next Time Around. This marks the halfway point in this series. Next month we'll return to the subject of "transmitters" and continue our examination of them. ☐

John W. Gore Memorial Scholarship

The FOUNDATION FOR AMATEUR RADIO, INC., with headquarters in Washington, D.C. announces the sixth John W. Gore Memorial Scholarship for either graduate or under-graduate study. The Scholarship for 1968-1969 consists of a $500.00 award. It may be re-applied for in succeeding years.

Licensed radio amateurs who intend making a career in electronics or related sciences may now apply for the 1968-1969 scholarship application.

To be eligible, applicants must have completed one year in an accredited college or university and must be enrolled in a course of studies leading to a bachelor or higher degree. They must also be radio amateurs holding a valid FCC license of at least a General Class rating. Preference will be given to applicants from the area served by the Foundation—the District of Columbia, Maryland and Virginia, although those living elsewhere are not excluded.

Scholarship applications should be mailed not later than August 31, 1968, and should be addressed to:

Chairman, Scholarship Committee
Foundation for Amateur Radio, Inc.
P.O. Box #5902
Bethesda, Maryland 20014

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A Two Dollar Phone Patch

Philip L. Writer W6TRU
5226 Vickie Dr.
San Diego, Calif. 92109

Again and again you have heard: it's cheaper to buy it ready made, or as a kit . . . "This statement has been applied to just about anything you find around the average ham shack these days; however, I feel the phone patch described herein is an exception to that rule.

This phone patch uses a standard telephone pickup of the type found as a common accessory for use with a tape recorder. The price for these items will vary from sixty cents to three dollars, depending where you buy it (I paid ninety-nine cents for mine). The pickup is a high impedance magnetic device which is connected to the phone by a vacuum cup. This allows the output from the telephone to be entered into the mike jack of the transmitter. The pickup is left permanently connected in parallel with the station microphone.

The next problem is to get the output of the receiver into the phone. This was accomplished by placing a 2" speaker (the kind used on most small transistor portables) near the telephone's mike. At first various methods of mounting were tried i.e. clips, plastic holders etc. In all cases the idea was to place the speaker near, but not touching the mouth-piece. It was thought that this would be needed to allow the station operator to talk as well as the person on the phone. After trying various methods it was found that no air gap was needed. The speaker cone is very thin and is almost transparent to sound. In other words, you simply place the speaker flat on the telephone and then talk through the speaker.

Two methods of mounting have been tried (they both work well): The first method is to use a small piece of tape to permanently mount the speaker in place. This method works fine if the phone isn't used by the XYL (some how they just can't go along with progress . . .) The second, and simplest, is to simply hold the thing in place with your fingers while holding the phone. Since the speaker is in direct contact with the telephone mouth piece, there is very little noise generated by this technique.

Cost? Well here is a complete bill of materials:

Telephone pickup	$0.99
2" Speaker	0.69
Phone plug	0.22
Sub-total	1.90
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TOTAL	$2.00

This bill of materials does not include two short pieces of wire, however as I said before, I paid ninety-nine cents for an item I later saw for sixty cents. . . . W6TRU

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Box 1
La Canada, Calif. 91011

Comments on the receiving problems that arise from a strong nearby transmitter, were made in *73 Magazine* for December, 1967. Tests have been made with a series-resonant trap placed across the receiving antenna lead, as shown on page 90 of the May, 1967, issue. This trap offered a means of reducing further the deleterious, pernicious, baneful and detrimental interference from a nearby ham's transmissions, especially on bands where front-end filters, described on page 14 of *QST* for August, 1967, are not available.

The specific problem was to reduce the signal from a nearby station operating on about 14311 kHz so that the first rf stage would not become blocked on other bands, even though the grid return had been removed from the agc line and drained through an rf choke to the muting voltage. An rf attenuator did not show any promise because of the disappearance of the desired signal. Turning down the separate gain control of the rf stage was not sufficient for much the same reason. Diodes placed across the rf stage grid coil happened to have a high capacity which did not permit realigning the receiver with the trimmers alone, although other diodes used singly or in series have not yet been ruled out.

The following measurements show that a 14,310 kHz series-resonant circuit consisting of a 50 $\mu\mu F$ variable capacitor and about a 3 μH coil, placed across the antenna input to the receiver, can bring about some improvement without seriously reducing desired signals removed more than 100 kHz in frequency:

Frequency	db change in SN/N ratio
7.0 kHz	0
14.0	3 gain
14.1	1 loss
14.2	8 loss
14.3	22 loss
14.35	25 loss
14.4	19 loss
21.0	0
28.0	0

The gain in receiver sensitivity at one frequency has been reported in the May, 1967 issue, and is presumed to result from an improvement in matching caused by the reactance of the series-tuned circuit placed across the coaxial line.

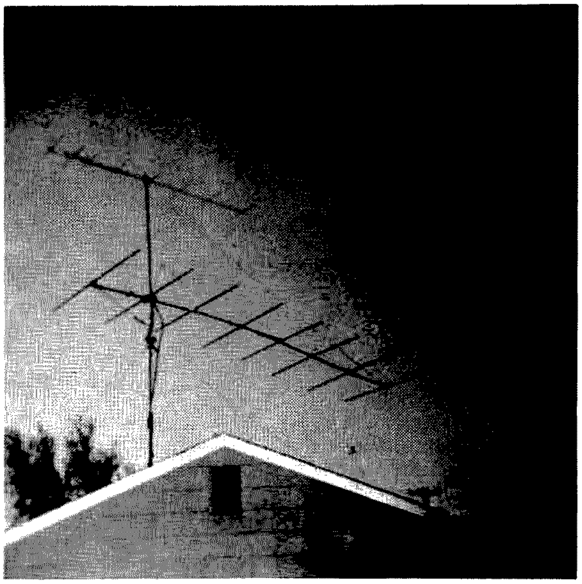
It will be seen that there can be some improvement in the 14 MHz DX Phone and CW bands, and considerable on other bands, when the series-resonant trap is tuned to the frequency of the nearby 14.3 MHz station. More than one trap can be used.

. . . K6KA

The Plan AHe$_{ad}$ Antenna

A don't do it yourself project

Richard Mollentine WAØKKC
19 Edgemore Court
Olathe, Kansas 66061



Obviously, from the photo, this is not the usual antenna article complete with dimensions, SWR readings, etc. An "April Fool" type structure, it is in reality a cut down eleven meter three element beam now resonating at six meters.

Originally I was happy with the three elements, however, like all things in life, we are trying to improve our lot. Because the mast was too small in diameter, the three element beam kept slipping. After trying C clamps, vice grips, shims, etc. I finally ran a bolt through the boom and mast, which eliminated the slipping, but made it impossible to move the forward or backward.

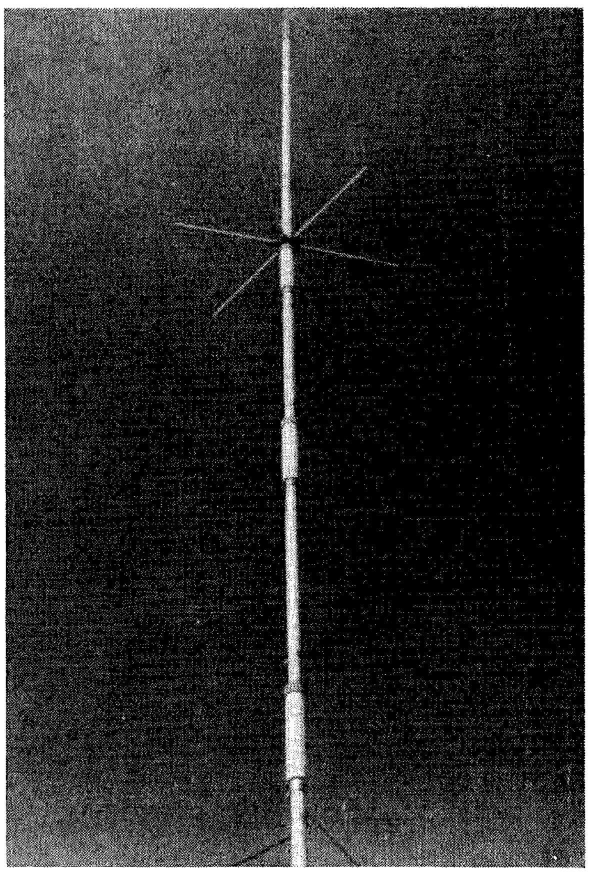
Looking up and surveying the puny three element array, I thought why not add one more element. After all, another element, another db gain. The antenna is only twelve feet above the roof, so it was a relatively easy matter to add additional elements just by standing on a ladder. So . . . one at a time, I added "just one millimeter more" and eventually wound up with this grossly off center monstrosity.

Nylon guys help to support the sag. I considered adding a weight at the reflector end to help counter balance the dead weight, but apparently the AR 22R Rotor which powers it is able to take the side thrust with no trouble.

So, although my antenna has the usual good forward gain, low SWR, and turns freely (even in the wind), this is an excellent example of the now quite familiar "PLAN AHEAD" sign. Anyway, how does one go about taking it down? Besides, with just one more element I could get an additional gain of —?

. . . WAØKKC

The Hustler 4-BTV Fixed Station Trap Vertical Antenna



Peter A. Lovelock W6AJZ,
235 Montana Avenue
Santa Monica, California 90403

I had been listening to glowing reports on the Hustler 4-BTV trap vertical antenna for almost a year before I decided to try one. A couple of previous experiences with trap verticals had left me somewhat hard to convince. Didn't they radiate equally badly in all directions, have bandwidths restricted to either the CW *or* phone bands, or change resonance in accordance with the relative humidity? However my California cliff dwelling precluded a beam, and horizontal dipoles fifteen feet above a metal flashed roof do not have the greatest vertical radiation angle.

Thumbing through the New-Tronics flyer, I was impressed by two claims. The 4-BTV was ruggedly constructed and would cover *all* of the 10, 15, 20 and 40 meter bands with no more than 1.6:1 SWR. There was even the option of 75 meter operation with a Hustler mobile loading coil added to the top of the 4-BTV. This permits 100 kHz bandwidth with no shorting of the loading coil to operate the four higher bands. The RM-75-S will take a full 2KW PEP while the lower cost RM-75 is good for most moderate powered transceivers, like mine.

Unpacking my new investment revealed the real truth in claims for the mechanical construction. The knocked down 4-BTV comprises four sections of heavy duty structural aluminum tubing, three thoroughly weather tight traps, a capacitive top hat assembly and a very heavy cadmium plated steel base for pipe mounting. The clamps for assembling the traps to the mast sections are fabricated from stainless steel. All parts are deburred and free from the hazardous edges that might interrupt assembly operations with an interlude for first aid.

Assembling the 4-BTV in accordance with the New-Tronics step-by-step instructions took all of twenty minutes. Three alternative methods for mounting the antenna are recommended: (a) at ground level with ground rods; (b) at ground level with radials and (c) roof mounted on a five foot pipe mast with radials. The last method is considered the best and was the one I used.

Radials are not supplied and the basic four band antenna requires approximately 145 feet of wire to provide two radials for each band. If the optional 75 meter top loading is used then 275 feet of radial wire is required. Any good quality antenna wire is suitable. A five foot TV mast section and a vent pipe clamp are also required for roof mounting.

Since the radials are attached to the mounting base with hardware supplied, it is easy to attach and detach the antenna without disturbing the radials, should you have to adjust for resonance at a desired frequency.

The sight of the 33 foot assembled 4-BTV with the RM-75 mounted on top gave me momentary qualms about attempting to hoist it into position unaided. Such fears were unfounded and I can attest that one average middle-ager can heft this lightweight onto it's mount single-handed, unless there happens to be a strong wind blowing.

Having carefully adjusted the section lengths and cut the radials according to instructions, I now anticipated a little pruning. But again I was wrong, the darn thing resonated just about in the middle of each band. Only for 75 meters was it necessary to loosen the clamp on the RM-75 and adjust the sliding top whip for exact resonance on my favorite frequency.

A SWR check on the completed antenna was highly gratifying. On the 10, 15, 20 and 40 meter bands, SWR at resonance was 1.5:1. At band edges maximum SWR was 1.25:1 compared to the 1.6:1 claimed. On 75 meters SWR at resonance was 1:31:1, while the bandwidth for an allowable SWR of 2:1 was a full 150 kHz rather than the 100 kHz advertised.

In operation, the performance of the 4-BTV surpassed my hopes and many satisfactory SSB and CW QSOs have been made all over the world using the moderate power of my Galavy V Mk 2 barefoot. During a recent CW contest WAC was made in the first 40 minutes. 40 meter DX has been excellent with S9 plus reports from the JA gang being commonplace. A slight drop-off in the shortest skip signal strengths on 75 meters, has been more than offset by the transcontinental contacts made possible by the lower angle of radiation compared to my previous dipole.

In these days of exaggerated superlatives it is a rare pleasure to find a product that outstrips its advertised claims. In my opinion those New-Tronics people are a conservative bunch, and the 4-BTV is a worthwhile investment for any ham who craves maximum performance under conditions of limited antenna space.

. . . W6AJZ

Specifications.

Length (basic 4-BTV)	21′ 5″
Impedance	Nominal 50 ohms
Power capability	full legal limit on SSB
Weight	15 lbs.
SWR at resonance (typical)	1.15:1
Bandwidth	1.6:1 at band edges 10 through 40 meters
Wind Loading	29 lbs. at 70 mph.

Propagation Chart

AUGUST 1968

ISSUED JUNE 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	7A	14	14A	21	21	21	21A	21A
AUSTRALIA	21	14A	14	7B	7B	7B	14	14	7B	7B	14A	21
CANAL ZONE	21	14	14	14	7A	7A	14	14	14A	21	21	21
ENGLAND	14	7	7	7	7	14	14	14	14	14A	14A	14
HAWAII	14A	14	14	7B	7B	7	7A	14	14	14	14A	14A
INDIA	14	14	7B	7B	7B	14	14	14	14	14	14	14
JAPAN	14	14	14	7B	7B	7B	7A	14	14	14	14	14
MEXICO	14A	14	14	7A	7	7	14	14	14	14	14A	14A
PHILIPPINES	14	14	14B	7B	7B	7B	14B	14	14	14	14	14
PUERTO RICO	14	14	7A	7	7	7	14	14	14	14	14	14
SOUTH AFRICA	14B	7B	7	14	14	14	21	21	21	21	14A	14
U. S. S. R.	7A	7	7	7	7	14	14	14	14	14	14	14
WEST COAST	14A	14	14	7A	7	7	7A	14	14	14	14A	14A

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7	7	7	7A	14	14	14	14
ARGENTINA	21	21	14	14	7A	7A	14	14A	21	21	21A	21A
AUSTRALIA	21	21	14	14	14	7B	14	14	14B	7B	21	21
CANAL ZONE	21	14A	14	14	7A	7	14	14A	21	21	21A	21A
ENGLAND	14	7	7	7	7	7B	14	14	14	14	14	14
HAWAII	21	21	14	14	14	7A	7A	14	14A	14A	14A	21
INDIA	14	14	14	7B	7B	7B	7B	14	14	14	14	14
JAPAN	14	14	14	7A	7B	7B	7B	7A	14	14	14	14
MEXICO	14	14	7A	7	7	7	7	14	14	14	14	14
PHILIPPINES	14	14	14	14B	7B	7B	7B	14B	14	14	14	14
PUERTO RICO	21	14A	14	14	7A	7	14	14	14A	14A	14A	21
SOUTH AFRICA	14B	7B	7	7B	7B	14B	14	21A	14A	14A	14	14
U. S. S. R.	7A	7	7	7	7	7B	14	14	14	14	14	14

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7A	7	7	7	7	14	14	14	14
ARGENTINA	21A	21	14	14	7A	7	14	14A	21	21	21A	21A
AUSTRALIA	21A	21A	21A	21	14	14	14	14	14B	7B	21	21
CANAL ZONE	21A	21	14	14	7A	7A	7	14	14A	21	21	21
ENGLAND	14	7B	7	7	7	7B	7B	14	14	14	14	14
HAWAII	21A	21A	21	14A	14	14	14	14	14A	14A	21	21
INDIA	14	14	14	14	7B	7B	7B	7A	14	14	14	14
JAPAN	14	14	14	14	14	7A	7B	7A	14	14	14	14
MEXICO	21	14	14	14	7A	7	7	14	14	14	14A	14A
PHILIPPINES	14	14	14	14	14B	7B	7B	14B	14	14	14	14
PUERTO RICO	21	14A	14	14	7A	7	14	14	14A	14A	14A	21
SOUTH AFRICA	14B	7B	7	7B	7B	7B	14B	14	14	14	14	14
U. S. S. R.	7A	7B	14B	14B	7	7B	7B	14B	14	14	14	14
EAST COAST	14A	14	14	7A	7	7	7A	14	14	14	14A	14A

A. Next higher frequency may be useful at this hour.

B. Very difficult circuit at this hour.

Good: 1, 2, 8-13, 16, 17, 19-27

Fair: 3, 4, 6, 7, 14, 18, 28-31

Poor: 5, 14

Note: VHF forecasts have been discontinued due to lack of reliable information.

Robert A. MacArthur K9UYA
724 S. Granfield Ave.
Hensdale, Ill.

Transit Time—SO?

I read in a book that the velocity of an electron toward the plate of a tube is $5.9^7 \cdot 10^7\sqrt{E}$ at the plate, where E is the plate-cathode voltage. Call this $6 \cdot 10^7\sqrt{E}$.

I learned such radio as I know before there was any such thing as transit time, and while I recognize that the scientific people have gotten around the poor behavior of the good old tubes at high frequencies by such things as klystrons, magnetrons, travelling wave tubes and such exotica, these diodes appear to me to be neither fair to an old timer nor necessary to a full life in amateur radio. Except that electrons in tubes are out where you can see them move, these new-fangled affairs are as bad as transistors.

This is a good place to take a swipe at the Engineers and the Handbooks, *all* of them. The latter show elaborate means of biasing the transistor and then they proceed to show circuit after circuit with the biasing resistors omitted . . . and not one word about why. The writers of handbooks and encyclopedias seem to feel that everybody already knows anything *they* know, and therefore leave it out. Or maybe they don't know anything. Either way we end up buying them all with no notable increase in knowledge. Anyhow, this bias thing puzzled me so much that I took a short evening course in transistors. I learned two things. One is that conduction in transistors is in part by holes. Nonsense. Conduction is moving charges and moving charges are not holes. You will not count holes on an ammeter—ammeters count electrons, not the places where they were. I also learned that transistors are "current operated". I know of very few electrical devices other than the electrostatic electrometer which are *not* current operated, but I never heard of a current that wasn't produced by a voltage applied to something. The purists will set up a clamor "what about a generator? Electrons are pushed aside by the magnetic field and set up the voltage". Not so, if they believe their own books. I take no responsibility for it, but the basic equation for the generator is:

$$E = N\, d\emptyset/dt$$

where E is the voltage across N turns of wire cutting Ø lines of force in one second. So!

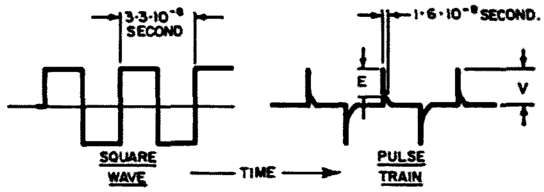


Fig. 1. Differentiate a square wave to make the pulses.

I didn't learn about the missing bias resistors. I figured that for myself. In no reference have I seen the clear statement that the resistance between the base and the emitter *is* a resistance and *is in parallel* with *any biasing resistor across the same elements.* I know very well that there are plenty of people who don't know this, so I will tell it here. If you want a bias of one volt on a transistor, don't put a 9000 ohm and a 1000 ohm resistor across 10 volts. Your 1000 ohm resistor is shunted by the base-emitter resistance of a few hundred ohms or less. Use a potentiometer and a milliameter in the emitter lead.

Getting back to the "current operated," if a class B2 tube is current operated, I'll swallow my words. I think the grid current is due to the positive grid voltage. I also think transistor base current is due to control element voltage. And I know that in both cases the current is something we would much much rather not put up with. How nice it would be if transistor input impedance were a megohm or so.

Now let's get technical. Although I can do a fair job of snarling up my bad neighbors TV with a wire hung on my grid dipper, I feel no harm is done by at least being able to provide more power at higher frequencies, what with UHF TV and all, if I can do it with my standard equipment.

I got the formula at the beginning of this paper from page 275 of Terman's "Radio Engineers' Handbook," McGraw-Hill, 1943. We'll engineer around transit time and we'll do it with any triodes you can lay your hand

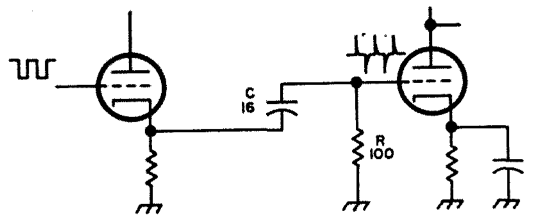


Fig. 2. Differentiator circuit.

on. From now on lets stick with Terman so that any objections you may have should be referred to him.

We're going to design a 300 MHz transmitter, and we'll use a duplex triode or two triodes as finals. Any power you want.

We first make a square wave. This is no problem at 30 MHz so we'll make it at that frequency using techniques that may be found almost anywhere in the literature. We will then differentiate the wave to provide the pulses, as shown in **Fig. 1.**

A suitable circuit is shown in **Fig. 2.** You will note that in this day and space age, 30 MHz is practically dc, so no problems.

With C and R 16 $\mu\mu f$ and 100 ohms, respectively, the width of the pulse to the standard 37% of maximum, as obtained from the formula:

$$V = E\, e^{-t/RC}$$

is conveniently $1/20$ of one Hertz at MHz, or a time of about $.0016 \cdot 10^{-6}$ seconds or $1.6 \cdot 10^{-9}$ seconds. If we use only the positive going pulses, we are going to get our 300 MHz power. If we use a standard inversion process, we can flip the negative pulses over and get 600 MHz power.

We apply these pulses—let's take the positive only—to the grid of a power tube. We'll also apply 225 volts to the plate of the tube. (We choose 225 volts because the square root is easy. We could also use 900 volts or 1600 volts and so on until our tubes are putting out real power).

From the Terman formula, the speed component of the velocity of the electrons near the plate is:

$$6 \cdot 10^7\sqrt{225} = 90 \cdot 10^7 = 9 \cdot 10^8 \text{ cm/sec.}$$

They are, see above, $1.6 \cdot 10^{-9}$ seconds long. They extend in the tube a radial distance equal to speed multiplied by time:

$$vt = 1.6 \cdot 10^{-9} \times 9 \cdot 10^8 = \text{about } 1.5 \text{ cm.}$$

This little blob of electrons will be completely absorbed by the plate in $1.6 \cdot 10^{-9}$ seconds.

Now what to do? we have another grid and plate either in the same tube (necessary for kilomegacyle power) or in another tube. We feed *this* grid with the same pulse delayed by $1.6 \cdot 10^{-9}$ seconds.

The delay is conveniently provided by a section of transmission line, as shown in the circuit **Fig. 3.** For open line, the length required is the velocity of light multiplied by the time the pulse spends in the line:

$$1.6 \cdot 10^{-9} \times 3 \cdot 10^{10} = 48 \text{ cm, call it } 50 \text{ cm.}$$

We shorten insulated coax cable by the velocity factor.

Now we connect the two plates together by a length of line. This can conveniently be folded into a quarter wave line as shown in **Fig. 3,** but note that this line has a total length of one half wave. What is the magnitude of this half wave? One end was hit by a pulse of electrons $1.6 \cdot 10^{-9}$ seconds before the other end. This corresponds to a half wave length of $1.6 \cdot 10^{-9}$ seconds, or a wavelength time of $3.2 \cdot 10^{-9}$ seconds. This is:

$$3.2 \cdot 10^{-9} \times 3 \cdot 10^{10} = 100 \text{ cm} = 300 \text{ MHz.}$$

We have the 300 MHz, but what is it's nature? We have applied one Hertz of excitation to our transmission line tank. We have to determine what practical value this has. Because of the pulse frequency of 30 MHz, or $1/10$ of the 300 MHz power frequency, this circuit is jogged once every 10 Hz.

The ringing time of a resonant circuit is defined as the time for the amplitude of oscillatory energy to decay 3 dB, and is found by the formula:

$$t = \frac{2\pi Q}{\omega} \text{ seconds}$$

A Q of 1000 is nothing for a good line tank, so ringing time of our tank is

$$\frac{2\ \pi \cdot 1000}{300 \cdot 2\ \pi : 10^6} = 3.3\ 10^{-6} \text{ seconds.}$$

This corresponds to

$$300\ 10^6 \cdot 3.3\ 10^{-6} = 1000 \text{ rf Hz.}$$

We note above, however that the tank is kicked every 10 Hz, well within the ringing time. Even with a (loaded) Q of 10, the

signal is very nearly continuous wave. From all I read, I gather that the little bit of 30 MHz hum modulation can easily be filtered out.

It also follows that with a 1 MHz signal and a Q of 100, the decay includes 100 Hz and the tank is jogged about every 33 Hz. KMHz power is obviously practical. There is no reason why the tank cannot comprise a jumper across two pins of a duplex triode.

The bad thing about transit time at high frequencies is that the element that starts electrons moving changes its mind before they get where they are going. I would point out again that the cheapest of surplus tubes can be used in this system because the tubes are operating at only 30 MHz. The 300 or KMHz voltage on the plates, as far as 30 MHz is concerned, averages the dc plate voltage. We've all seen a dc voltmeter tremble when measuring a mixture of dc and 60 Hz ac—it still reads dc correctly.

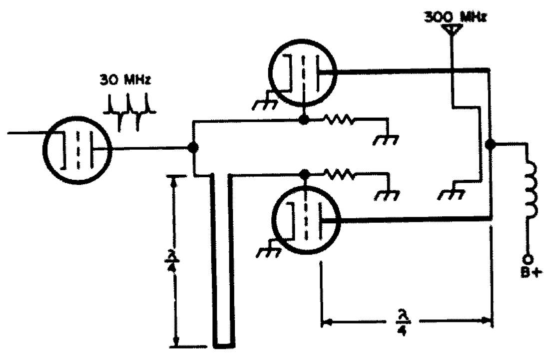


Fig. 3. UHF Transmitter.

Whose afraid of transit time?

... K9UYA

INDIANA QSO PARTY RULES

August 17-18, 1968

All radio amateurs are invited to participate in Indiana's QSO Party sponsored by the Indiana Radio Club Council, Inc., Certificate hunters will find this party an excellent time to work for the Hoosier "500" Award. For full particulars on HFA, SASE to Hewitt Mills, WA9LTI, IRCC Sec'y, 289 West Sumner Ave, Martinsville, Ind.

QSO Party Rules: 1) The Party will begin at 2300 GMT Saturday August 17 and end at 2300 GMT Sunday August 18, 1968. 2) The general call will be "CQ IND" with Indiana stations adding "from IND" to avoid confusing with other ninth call area stations. 3) All bands and modes may be used. Valid contacts are made between stations on the same band and mode. Same stations may be worked on different bands or mode for additional contacts only. 4) Exchanges must include contact number, call, Indiana county, state, province, or country. Indiana stations may add HFA points after county. 5) QSO Party scoring: Indiana stations multiply all contacts by number of different states, provinces, or countries worked. Others multiply the number of contacts by the different Indiana counties worked. 6) Awards: Plaque to highest scoring station within and outside of Indiana. Certificates to highest scoring station in each Indiana county, each state, province, or country. Multi-op stations are eligible for certificates only. Judges decisions final. 7) Submit logs showing date, time, contact number, calls, mode, band, county, state, province, or country, and point summary. Block print your call, mailing address including zip code, and operating address if different. Include signed statement that all rules have been observed. Send logs (no HFA, please) to Robert A. Lyles, K9HYV, 706 Spring St., Michigan City, Ind. 46360 on or before September 16, 1968. Please enclose SASE for copy of results. Good luck!

City of New Orleans Commemoration

In commemoration of the celebration of the 250th anniversary of the founding of the City of New Orleans in 1718 by Jean Baptiste Le Moyne, Sieur de Bienville, the Greater New Orleans Amateur Radio Club is offering a commemorative certificate. This certificate is available to any amateur radio operator who submits a log extract indicating two-way communication on any bands, in any mode, with three Metropolitan New Orleans Area amateurs during 1968.

In addition to the log extract, interested hams should send a large self-addressed stamped envelope to the Greater New Orleans Amateur Radio Club, 2935 International Trade Mart Tower, 2 Canal Street, New Orleans, La. 70130. The certificate for this award has been designed by John Chase, internationally known political and editorial cartoonist.

WCARS

The all day, every day net

More than 500 radio amateurs from all over the Western United States and Northern Mexico belong to a network called the West Coast Amateur Radio Service dedicated to maintaining one clear channel on the amateur bands—7255 kHz. Participants monitor this frequency so long as conditions permit during the daylight hours for the purpose of providing service to the public and other amateurs. Any amateur station requiring any kind of assistance can get help merely by calling in. The Service is a kind of giant intercom or party line throughout the West that is instantly available for communicating information and requesting assistance in any emergency.

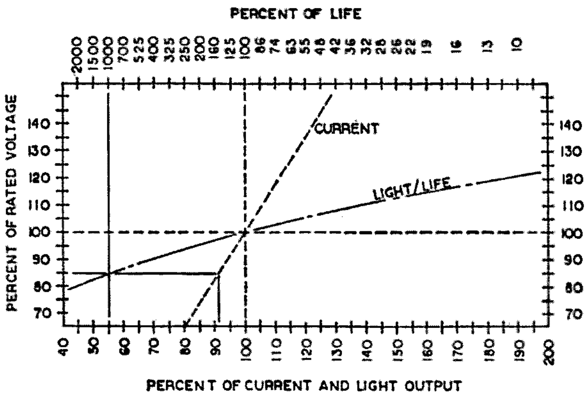
WCARS participants with mobile equipment called in 60 unreported highway accidents in 1967 for relay by base stations to the proper authorities. Mobiles also reported many freeway hazards and motorists needing assistance. Other vital communications included those relating to blizzards in California, Arizona, and New Mexico; floods in Alaska, hurricanes in Mexico, fires, lost planes, boats, and people as well as medical information to such widespread spots as Thailand and Peru. Aside from the urgent incidents, hundreds of routine communications are handled or arranged. For example, Navy and other ships in the Pacific call in regularly to arrange phone patches to their families back home.

The California Highway Patrol is a member of the Net with three patrol owned amateur transceivers with CHP amateur operators available to maintain liaison during extended emergencies. 3952 kHz has been designated as an alternate frequency when required for night time operation. ■

SUBSCRIBERS

We want to make absolutely sure that no one is using our 73 mailing list. We do not rent this list out as do other magazines. If your address label from 73 is distinctive and you find that you are getting any mail addressed in the same distinctive way please let us know immediately and send us the envelope or wrapper that you received so we can take appropriate action. Your help in this will be very much appreciated.

Increasing Pilot Lamp Life



Burned out pilot lamps are annoying, particularly so when equipment has to be disassembled to gain access to bulbs which is the case with my Heath HW32A transceiver. After a couple of disassemblies, I decided to eliminate the problem once and for all. A 200 volt, ½ ampere diode (because it was available) was inserted in place of the jumper wire that connected the two HW32A lamps in series (the diode operating as a rectifier eliminates one-half of the ac wave, thus, causing half normal voltage to be applied to the lamps). Of course, the light output from the lamps is reduced; however, there is still sufficient light to accomplish the intended purpose of the lamps.

Curious as to just what percentage increase in lamp life could be expected by reducing lamp voltage, the following chart was put to use to see what happens when lamp voltage is decreased just 15 percent, draw a horizontal line from the 85 percent mark on the Percent of Rated Voltage scale until it intersects the "Life/Light" curve. Then draw a vertical line from this point to hit the upper and lower scales. Note that light output will drop to 54 percent and lamp life will increase to 1000 percent. To check the effect on current by decreasing lamp voltage, continue the horizontal line across until it intersects the dotted line representing current. Draw a vertical line from this point down to the bottom scale, and see that current will drop eight percent.

Since I have reduced lamp voltage by 50 percent, my previous statement that I'd fix the lamp problem "once and for all" appears to be no idle remark. Those lamps might outlast me. . . . WB6ZOA

De-Humming the Swan

Some hams prefer to receive with a good loudspeaker or crystal headphones, rather than with those of limited frequency response. When this is done, 60-cycle and 120-cycle hum can be much more evident. The problem is to cure the hum.

In the Swan 350 and 500, the audio line also is used for the ac heater current, producing 0.1 volt of ac at the headphones. If a step-up transformer is used to match crystal phones, the ac measures 12 volts without a signal! The quick and easy answer is to connect a low-resistance braid or group of parallel wires between the transceiver and its power supply. A connection at the power supply is easy—with lock washers, put a machine screw through a lower louvre slot, tighten the nut, and put a soldering lug (soldered to the braid or wires) under a second nut. If the wires are short to the transceiver ground terminal, and connections are low resistance, the hum practically disappears.

A more sophistcated cure is to add a wire in the cable between pins #11 which are unused. At the power supply, pin #11 can be connected to #6 or, better, to the grounded headphone jack. In the Swan 350, the ground can be lifted from the output transformer and the latter connected to pin #11; in the Swan 500, the ground can be lifted from terminal #3 of relay K2, and the terminal #3 connected to pin #11. This avoids having a common conductor carrying the audio and ac filament current.

Those bothered with 120-cycle hum in the Heathkit SB-300 may add the approved field-change which puts another section of RC filter on the power supply. If there is 60 cycle hum, remove the output transformer from the rear apron below the power transformer, and mount it on the convenient aluminum shield above a printed-circuit board about 8 inches forward.

E. H. Conklin K6KA

Hamfests

Selling subscriptions at hamfests and conventions is an exercise in frustration these days. At least 75% of the visitors to our booth come up to tell us how much they like 73 and how many years they have been subscribing. This is nice, but it doesn't do much to defray the enormous expenses involved in exhibiting.

Kayla represented us at Dayton this year. The ARRL has apparently relaxed a bit and 73 was permitted to exhibit at Swampscott and the National Convention at San Antonio. At Swampscott they even let me show slides of my trip to Africa and Nepal. I didn't expect very much of an audience with the shows scheduled for the very first and very last spots on the program, but the rooms filled to overflowing for each show.

Lin and I had a wonderful time visiting Hemisfair in San Antonio. I put on four pounds in as many days eating at the hundred or so little food booths. We ate steadily of Mexican, Belgian, German, Swiss, French, and Texan food, rarely repeating ourselves. The lines were mercifully short at the interesting movies and exhibits, so we got to see all of the fascinating things that we missed at Expo last year. The National Convention was well done, but I suspect that the remoteness of San Antonio and the fear of escalated prices due to the fair may have kept many away. We found prices very reasonable, though I must admit that we "lucked" out of eating at some of the really expensive restaurants. I believe that the registration was on the order of 1500 for the convention. I know I missed a lot of the faces that I usually expect to see at a national convention.

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Surplus 220 Volt AC Circuit

There have been cases in the last couple of years when odd values of ac were needed for simple experiments here at WB6NWW, and since there are no 220 volt lines installed in the shack a little ham ingenuity and a few phone calls to the local Old Timers brought the answer: use a 110 volt transformer and a 220 volt transformer with secondaries of the same voltage and current back-to-back. This seemed like a FB idea so a few minutes rummaging through the junk box (mine is quite large) brought up two ideal army surplus transformers which had been lying idle ever since their purchase at a local swap meet. The wattage capability of this circuit is limited to the capacity of the voltage and current of the secondaries of the transformers. Both of my transformers were rated at 28 volts at 10 amps, so a little bit of Ohms Law told me that I could draw about 280 watts from the 220 volt "output" side. Incidently, for our foreign readers: the primaries of this circuit can be reversed if 110 volts is desired from a 220 volt source.

A quick look through the pages of surplus catalogs or a look through the advertisements in this magazine will more than likely locate you a set of transformers with the required voltage and current values at a modest price.

. . . Marty Hartstein WB6NWW

New Ways to Diagnose Electronic Troubles

Things do inevitably break down. You, as an electronic genius, are supposed to be able to fix them, according to your neighbors. This book will help bail you out of almost any scrape you may get into along this line and might even save you a trip to Leger Labs the next time that little curl of smoke comes out of the rig.

Published by Tab Books, Blue Ridge Summit, PA 17214, this $3.95 paperbound book makes even the most complicated circuits seem simple, from radios right up through color TV. Service men work out shortcuts for finding difficulties, though this usually takes years of experience. Seldom do you find one exposing what are considered trade secrets the way this book does.

Letters

Dear 73,

Lately I've read a few comments on the intruders in the 40 meter band. It is my opinion they present us with a golden opportunity to demonstrate our skill as radio operators.

Having seen the Heath SB-101 with its 400 Hz filter, it is my opinion that anybody with this kind of equipment could work as close as 200 Hz from the intruder's carrier.

This suggests a contest. I hope somebody with more experience and skill than I agrees to organize some.

Bon F. Harbin WA8DBO

Dear 73,

I agree 100% with the May editorial on Foreign Broadcast interference. Yesterday and today I logged the following intruders on our 15 meter band: May 9, 1530-1600, 21.32 MHz; Armed Forces Radio and TV Network . . . S5-6. May 10, 1800-1830, 21.445 MHz; Voice of Democratic German Republic (transmits in French). 1800-1830, 21.360; Radio Prague. 1930-2030, 21.437 MHz; Voice of Africa in Arabic. S7-8.

Why not devote a section of 73 to reports of freq., times, and identity of these new intruders. Then other hams could log the intruders, confirm their call and have something definite to say when protesting to FCC, ARRL, and the intruder stations themselves. I'm willing to spend some of my valuable operating time listening to these intruders, logging them and writing letters. Let's get as many hams doing that as possible. Complacency will only result in 15 becoming like 40 is now. There is no time to lose!

Gabe Gargiulo WA1GFJ

Sounds good to me. Send your logs and I'll list them each issue. Then we can turn them over to the proper authorities.

Dear 73,

I am 100% for your policies against broadcasting intruders and hope that every ham will participate in eliminating them from our bands.

Edwin Barnett WN2DYD

Dear 73,

Your "Editorial Liberties" in the May issue touches on one of the most crucial problems facing amateur radio today. The steady influx of international broadcasters on our bands is without a doubt gradually pushing us off the air.

Will we be ultimately driven off our reservation and relegated to the dummy antenna "happy hunting ground" on these frequencies? The answer is an emphatic "yes," unless we start using these frequencies and reduce the listening audience with QRM.

I refer you to the excellent article by WB2CPG in the March 1968 issue wherein he states that the FM mode requires only 6 db or two times the signal strength of the interfering signal to wipe out an AM signal using a discriminator detector. Here then is the answer to joint frequency occupancy on these bands. There are a lot of old AM rigs around with NBFM capability and a simple NBFM adaptor for the receiver should be well within the construction abilities of most hams

How about it? Let's form a QRM net on 40 on a transcontinental basis as a beginning. Perhaps this would be a good place for the UFO net to operate. It might even offer the amateur a good opportunity to develop a "new" communication technique and thus further the electronic art.

F. J. Bauer W6FPO

Dear 73,

A recent editorial in 73 mentioned the illegal operation going on in the Citizen's Band. I was surprised to hear this existed, so I built a simple converter for my NCX-3 which tuned 11 meters. When I tuned across the band, I got the shock of my ham career. Profanity, music, hate messages, all the rules set by FCC were being broken by hundreds of "bootleg" stations. The legal operations were having no easy time trying to carry on communications.

It seems the FCC has their hands full because of the multitude of these illegal stations. They don't have enough men and equipment to track down all these stations. The legal stations are not organized enough to do much on their own. Did we give up 11 meters to create a playground for any illegal station that wanted to amuse himself at the expense of the legal CB stations? If you find all this activity hard to swallow, get an 11 meter receiver and take a listen.

Now, after you've become interested, you want to know what we as amateurs can do. By helping the CB operators we might also gain a little goodwill. We can start by letting the FCC know we want to help. Then we can get out the old direction finding loop, 11 meter converter, and track these illegal stations. We can then report them to FCC and let them investigate further. Besides, it might be more fun than a club transmitter hunt! In this effort, we will also be involved in public service. But, if we remain uninterested, we might find them taking over **our bands!**

Jim Brenner WA6NEV

Dear Wayne,

I have been sitting back and reading 73 without much real complaint. But being a human being and a fellow ham, here I go. On page four of the June 1968 issue, the E.I.A. has flipped!

1. Novice code speed is simple as all hell. Even I got that **two years** before I mastered the theory, and I'm only 14.

2. I was on two meter AM for a while, and it spoiled me. It took a while to get my speed up to 15 wpm; AM simply ruined me. I think Novices should have no phone privileges at all.

3. The only thing wrong with this part is that above 29.1 megahertz, it's dead. True, this would be ideal for Novices, but isn't 15 meters enough?

4. If the Novice was renewable, think of all the crummy QRM we'd have. And five years? Who would graduate? A straight 2-year license (mine was one year) is good enough, and enough time is provided for the Novice to decide whether he wants to continue it.

5. Why? After a Novice expires, he is supposed to advance, or (God forbid) quit.

Paul T. Snyder WA3HWI

Dear Wayne,

In regard to your comments on the E.I.A. and it's proposals concerning Novices in the June issue, I am almost in complete agreement. There are two points on which I disagree, however. I don't think Novices should be allowed phone privileges on any band. This may sound strange since I am a Novice at present. I feel that if Novices were allowed to work phone on 29.5-29.6 MHz, he would spend all of his time working DX on phone. I know that if I had had this privilege, I would probably give up hamming when I had to face a General exam at the end of my license term.

Good code proficiency is, I believe, necessary to hams. I am not cutting down AM and SSB ops, but I think it takes a better operator to work CW efficiently than it does to talk into a mike. I now wait with bowed head for the storm.

Larry Irwin WN4HLX

Dear 73,

Basically I am not a home brew man; in fact I deplore it due to a visual problem. Nevertheless, I enjoyed the June Surplus issue. I picked up many tips that I would like to try in my shack. I would like to see more issues of this type. Very good issue.

Paul J. Rilling WA3HIT

Dear Wayne,

Opportunity knocks! I understand that a "Tornado-belt" senator, taking advantage of a rare tornado warning in the Capitol City, rammed through a measure to initiate a study on how a tornado warning system could be built. The news article also implied that he stated that the biggest single problem would be rapid communications from one community to another. Then I remembered your editorial about the UFO Net.

A net on eighty would provide appropriate coverage day or night. One or more enterprising hams in each county in these parts of the country could make contact with the ESSA man. Usually there is an office with friendly, helpful weather men at a good sized airport. (and they have land-line teletype to other offices.)

An effective tornado alert net would be well within our capabilities, would perform a very valuable public service, and might aid those who would like to study these still unpredictable destructive storms. One would be obligated to have emergency power to be a serious contender, since power is often interrupted. Such a net might also prove the value of the UFO net idea in a dress rehearsal with an immediate motivator for a goodly number of hams.

I only wish I had been paying closer attention to the radio when the original news item was broadcast. This is a MARS station AB8AG in NHA TRANG, Viet Nam, and we were running phone patches with A6NAZ at the time. Even listen to a newscast and run a phone patch at the same time?

K1VYQ

W1EMV from page 2

circle and the first one would whisper a sentence into the next person's ear. By the time the sentence reached the last person, it was completely different. On the ham bands one person would report the actual fact that Alan Biggs' boat had taken on water and they had asked for aid from the Coast Guard. This would be passed on as "Hey, did you hear that Alan Biggs is lost at sea and is sinking. It was, unfortunately, the wild exaggerations which reached the newspapers.

Ham radio can do a lot of good by maintaining good liason with services such as the Coast Guard, but I doubt if those services appreciate the false newspaper reports which sometimes follow. If you are involved in such a situation as the one I have described, report only the facts as they happened and of which you have first hand knowledge. Don't report rumors. This can only hurt our public image.

. . . Kayla W1EMV

Afghanistan Operation

V. P. "Peyt" Lager, K9HWI, has disclosed that immediately following the end of the school year at Barrington, Illinois, High School he will leave for a two year stay at Kabul, Afghanistan, where he expects to operate as YA2HWI.

Peyt, head of the Industrial Arts Department at Barrington High School, will be Supervisor of Building Trades at the Kabul Institute of Technology, under the United States A.I.D. program.

Including a complete ham station within the baggage allowance, while still shipping a full two year's supply of basic necessities for himself, his wife, and his daughter, has taken close planning. Peyt will be running a Heath SB101 transceiver and a Heath SB200 linear into a tri-band beam. For 40 meter operation he will load the mast or erect a long wire antenna. The present Hallicrafters station receiver will also make the trip, but to be used as the family radio.

Most operation will be on the low ends of 20 and 40, and in the novice portion of 40. the exact date on which operation will commence is undetermined, and will depend on the demands of the new job, establishing living quarters, awaiting the arrival of equipment traveling by surface shipment, and getting the station set up.

YA2HWI's Stateside manager will be W9FLJ of Barrington, Illinois. No replies without s.a.s.e. or I.R.C.

"I do hope it works. He's been working on it for thirty years."

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Telephone op. headset (Western Electric) .... **$ 8.50**

Minimum order $5.00. Sorry, no catalog at this time. Write for specific items. Watch for our future ads in 73. Stop in and see us when you're in St. Louis.

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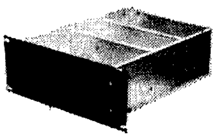

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HAM-TV, CCTV CAMERA $110.00, Toshiba 7038 Vidicon—$15.00, Elgeet 4" (102 mm) F:2.7 lens, Toshiba 7038 Vidicon—$8.00. WB2GKF Stan Nazimek, 506 Mt. Prospect Avenue, Clifton, New Jersey 07012.

NORTH ALABAMA HAMFEST ASSOCIATION, Inc. Hamfest to be held in Huntsville, Alabama, August 17 and 18, 1968 at The Mall. Contact James A. Brashear, WB4EKJ, for details.

TIE CLIPS: Gold plastic with your call letters engraved in black. Satisfaction guaranteed. $1.25 each. Elderkin Engraving, Box 5622, Pasadena, Calif. 91107.

DX-60A with PTT built-in, $65; HG-10B VFO, $30; Lafayette HA-63 .540 to 31 mHz. with speaker, $40. Want HT-37. WA9TEB, 67 Bowen St., Oshkosh, Wis.

WANTED: Used Davco DR-30 Receiver in operating or repairable cond. Price and description to N. F. Moss, 7535 Perry Rd., Bell Gardens, California.

TRY YOUR DOLLARS where they are worth more. Send for free list. TR4—495.00—AC4—79.00—SW4A—275.00—RB4-T-4XB—both 750.00—MN4—75.00—NCL2000—495.00—NC200+AC200—395.00—SWAN 350—375.00—500—495.00—All Units New. Freck Radio & Supply Co., Inc. We trade, 38 Biltmore Ave., Asheville, N. Car. 2801.

QSL CARDS, 1 color $8.40, 2 color $10.40, per M. High gloss card, 7-day service. Write for free brochure. Pacific Litho Print, Box 156, Waldport, Ore. 97394.

WANTED: Young, aggressive, full charge amateur store manager for full line Florida amateur stores. Health insurance, profit-sharing, stock option. Please submit brief resume with salary requirements to: Box 868, 73 Magazine, Peterborough, N.H. 03458.

PRINTED CIRCUIT BOARDS made to your specifications from schematic to finished board. Stafford Electronics, Greensboro, North Carolina 27401.

TRADE EVEN: Have new boxed Swan 500C with 117XC for any of the following surplus sets: SG-1A/ARN with PP-348; SG-2/GRM-4; SG-13/ARN; MD-83A/ARN; ARM-47; UPM-98 or 99; R-390A/URR; ARC 102; 618T; Phone collect for trade (813) 722-1843, Bill Slep, W4FHY, Slep Electronics Company, 4214 Highway 301, Ellenton, Florida 33532.

"SAROC" FOURTH ANNUAL fun convention scheduled January 8-12, 1969, in Hotel Sahara's new space convention center, Las Vegas, Nevada. Advance registration closes January 1, 1969. Ladies program in Don the Beachcomber. Technical seminars, FM, MARS, RTTY, QCWA, WCARS-7255. Registration $12.00 per person entitles "SAROC" participants to special room rate $10.00 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Sahara's late show, Sunday breakfast equal to any banquet dinner, ask any "SAROC" veteran. Brochure planned November mailing for details QSP QSL card with ZIP Southern Nevada ARC, Box 73, Boulder City, Nevada 89005.

DRAKE 2-C RECEIVER with 2-CQ Q Multiplier and 2-AC crystal calibrator, 2-NT transmitter with 40 and 80 meter novice crystals. Mint condition. $295.00. Gary M. McGlothlen WAØRAM, 911 Fairview Place, Fairfield, Iowa 52556.

PEORIA HAMFEST: September 15, Peoria, Illinois —same place as last year. Advance registration: $1.50. Write: Ferrel Lytle, W9DHE, 419 Stonegate Road, Peoria, Illinois 61614.

SELL CQ most 52 through 67, QST many 37 through 54, 20¢ each post paid. D. Sinner W6IWO, 15310 El Camino Ave., Paramount, Calif. 90723.

JULY 1966 ISSUE OF "73" NEEDED. Anyone care to sell me their copy? E. E. Merkel, 9204 Mintwood St., Silver Spring, Md. 20901.

SALE: HT32 and RME6900 in good condition. No shipping. $390.00 takes both. K1LBK, 17 Brownehill Ct., Lincoln, R.I.

TRANSCEIVERS: HW-12 $79.75, Eico-753 $119.95, Galaxy III $179.00. All in excellent condition, never used mobile. First certified check. Alfred Wilson, Jr., Rte 1, Box 450-B, London, Ky., 40741.

FOR SALE: Swan-240 with AC supply. 240 watts pep; 80, 40, and 20 meters. Excellent condition with all manuals. $240 or best offer. Ben Lowe K4VOW/5, Apt. 180, 900 W. Spring Valley Rd., Richardson, Texas 75080.

POWER SUPLY REGULATOR zero to 20 volts continuously adjustable at currents to one ampere. Spec sheet free, catalog 25¢. RADEVCO, Box 8450, Baltimore, Md., 21234.

SELL: Heath HA10 amp., $165. Link 1907 FM basestation with mobile transmitter and receiver, $125. My handicap limits "hamming." Ron Perry, WA2CGA, RD #1, Fishkill, N.Y.

SWAN 250+ 117xc P.S. $350 or trade, mint condix. WA2DOP Bob Gilmartin, 1 Brook Run Dr., Mount Holly, N.J. 08060.

HAM TV—2 camera chains; Packard Bell vidicon camera, rack electronics, 14" monitor, tripod, studio cables. Orig. cost $3,800 ea. $425 ea or trade HF linear or mobile SSB Xcvr of equiv. value. Extra monitor $40. WA6JMF, 12712D S. Ramona, Hawthorne, Calif. 90250.

Aug 1968

WRL'S USED GEAR has trial—terms—guarantee! 99er—$79.95; SR46—$99.95; HW12—$89.95; SR150—$299.95; Galaxy V—$289.95; V Mk2—$329.95; Viking 2—$79.95; GSB100—$169.95; HA10—$189.95; 75A2—$189.95; SX101A—$189.95; NC300—$149.95; RME6900—$159.95. Hundreds more—low prices. Free "Blue-Book" list. WRL, Box 919, Council Bluffs, Iowa 51501.

GLEGG THOR 6 with AC power supply, manual, good condition. $140.00. Firm. Money order, shipping your expense. Zig Porada, 40 So. Glenwood Dr., Bergenfield, N.J. 07621. WA2ZWB.

SO. CALIF.—DuMont 304H Oscilloscope; clean, unmodified, with complete Manual. Perfect operation. $50 or trade. J. Sandberg K6YPU, 1138 E. Rustic Rd., Escondido, Ca. 92025.

GONSET G-76 100 watt 80-6 Meters transceiver, $150. Hallicrafter SX-100 $100. Hornet tri-bander beam w/rotator $50. Tandberg 6 tape recorder $150. All in excellent condition w/manuals. K6QAT, 13709 Ardis, Bellflower, Calif.

TELETYPE MOD. 14 reperforator w/automatic tape take up rewinder, new, unused, $69.95 . . . 4-400's $14.95 . . . transformers: plate 5KV-1.6ADC $59.95 . . . modulator 811As $35 . . . filament 12.6VCT-10A $4.95, ideal for transistor supply, battery charger . . . catalog 10¢. Fertik's, 5249A "D", Philadelphia, Pa. 19120.

31ST ANNUAL HAMFEST of the South Hills Brass Pounders and Modulators, Inc. of Pittsburgh, Pa. will be held Sunday, August 4, 1968 from 1 to 6 p.m. at St. Clair Beach (Old Paris Lake) 5 miles south of Mt. Lebanon on Route 19. Plenty of picnic space for the family. Check-ins on the Club Station W5PIQ on 10 and 6 meters. Registration for door prizes $2.00 at the door or $1.50 in advance. For further information or pre-registration write Leonard R. Hendry, WA3GKL, 248 Skyport Dr., West Mifflin, Pa. 15122.

NATIONAL INCENTIVE LICENSING POLL RESULTS—639 against and 178 for. Our ads were in the three leading ham magazines. WB2NOD, Box 685, Moravia, N.Y. 13118.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

LOUISVILLE HAM KENVENTION, Saturday, August 31 at the Executive Inn, featuring Dealers and Manufacturers; Technical Forums; Prizes; Contests; Fashions for the Ladies. 648 South Fourth Street 40202.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB. P. Wandelt, RD # 1, Unadilla, New York 13849.

THE QUAD CITY AMATEUR RADIO CLUB has scheduled its annual Mississippi Valley Hamfest for August 18, 1968 at the Rock Island Arsenal, Rock Island, Illinois. The site this year is an all-weather site with adequate display facilities. Lunch will be served in the cafeteria. Price for tickets is $1.50. Contact John E. Greve, W9DGV, 2210-30 St., Rock Island, Ill. 61201 for advanced tickets. Frequencies to be monitored are 3900 50.4 and 146.94 mc.

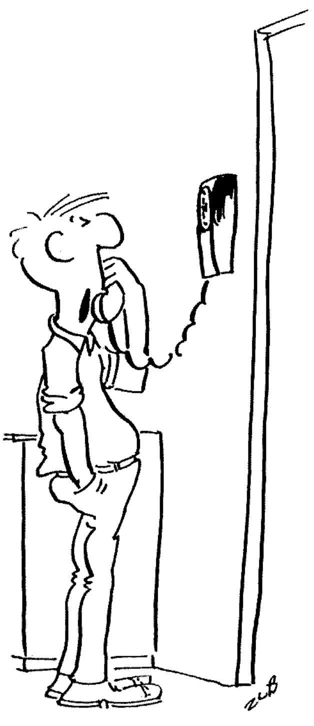
THE MT. AIRY V.H.F. RADIO CLUB is holding its 13th Annual Family Day and Picnic on Sunday, August 11 (rain date August 18) at Fort Washington State Park, Flourtown, Pa., in cooperation with the Delaware Valley Chapter of the QCWA. Come and get together with your families and friends for an old time outing of games, cook-out and just plain relaxing for a day away from home. There will be games for the kids and activities for the YL's and XYL's. Free soda for all. No reservations required. $2.00 per family.

SELL: Hallicrafters "Hurricane" Transceiver SR-2000 PS-2000 Factory sealed, unopened cartons. Warantee. Sacrifice offers. E. Crieco, 54 Andrew St., Meriden, Conn. 06450. (203) 235-9944.

WANTED: Drake T4X transmitter and power supply or Heath HX-10 Marauder transmitter. Must be in excellent condition and not modified. Reply Box 8, 73, Peterborough, N.H. 03458.

THE CENTRAL NEW JERSEY VHF SOCIETY is holding another antenna measuring contest this year. The antenna measuring contest will be for both 432 and 1296 MHz, with improved technique (improper gains were measured last year due to reflections picked up by the reference dipole). The contest will be held as part of our Hamfest on August 18, 1968 at Johnson's Park, New Brunswick, N.J. For further information contact Paul Wade WA2ZZF, 48 Warrenville Rd., Middlesex, N.J. 08846.

432MC CONVERTER. Convert to 7-30MC. Removed from missile guidance system, size 2" x 3" x 3½", 2 tubes-2 diodes, complete with schematic & instructions less crystal. Unused $14.95 each. Also 1000V PIV, 1.5A Epoxy diodes, 45¢ each, 10 for $3.99. Tubes 6146A, unused, $1.00 each. We pay postage on prepaid orders. Alpha-Tronics, Dept. A, 14251 East Colfax, Aurora, Colo. 80010.



"...NOW TAKE THE LEAD OFF THE TOP OF YOUR POWER TUBE, BUT FIRST DISCONNECT YOUR SET, HELLO, HELLO, ...FRED..."

73
SEPTEMBER 1968
73¢ Yet
AMATEUR RADIO
P-34
JIM
WAGNEV

73 MAGAZINE

September 1968
Vol. XLVII No. 9

Contents

Departments

73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S. Entire contents copyright 1968 by 73, Inc. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.
Stop reading this fine print. Look at page 92 and go out and sell subscriptions.

Editorial Liberties

I would like to take this opportunity to introduce 73's new Technical Editor, Jim Ashe W2DXH. Those of you who are among 73's Fandom will recognize Jim from his many fine articles in the past few years. I consider myself fortunate that Jim agreed to come to work for us, where he will be underpaid, overworked, and rewarded mainly by knowing that he is helping to maintain (would you believe improve?) 73's standards for technical articles. He's only been here two days as of this writing, and he has pitched in like a trooper and is taking much of the load off my shoulders and mind. It's nice to have a man around the shop! Look for great things!

Hardly a day goes by when I don't receive at least one letter from an amateur saying that he has given up CQ and QST and only subscribes to 73. This is flattering, but . . . ! I'm not opposed to your dropping your subscription to CQ, but when you drop your subscription to QST it means you are no longer a member of the *only* organized body devoted to amateur radio and it's purposes.

ARRL may not be the best, but, let's face it, ARRL is all we have. If you are unhappy with what the League is doing (or not doing) you won't accomplish anything by resigning any more than you will change the Government by refusing to vote. If you don't like what the League is doing, this is the time to speak. Elections for Division Directors and Vice Directors are taking place in the following Divisions: Central, Hudson, New England, Northwestern, Roanoke, Rocky Mountain, Southwestern and West Gulf. If your director has not done what you feel is to the betterment of ham radio, get out and do something to change it rather than resign.

The rules of the game are roughly as follows. To be a Director or Vice Director you must have been a member of ARRL for five consecutive years without a lapse. You must have a nominating petition signed by 10 League members to HQ by noon on September 20, 1968. You must hold a General Class (or higher) License. And, you should be prepared to work hard to improve the deplorable conditions which now prevail.

If your are not in a position to run for the office, you might take a close look at the man who is opposing the incumbent in your Division. You might just find that you have a pretty good guy who is willing to work hard to give ham radio the necessary boost.

I certainly don't want to stir up the late AM-SSB quarrel again. I work SSB/CW/AM in that order of preference (when I have time to be on the air at all) and feel each has it's place in our hobby. However, there is AM and there is AM with so-called "Super Modulation." The lead article in July CQ on "Modulation Unlimited" seems to me to be a matter of irresponsible editing. That article was in the files at 73 when I came to work here last year. We had paid for it, but the check had never been cashed. I read it and thought what a wonderful article it was for about 15 years ago. It contained nothing new. 73 had already printed a similar article in Feb., 1963. The drafting had been done, the article was already in type and ready for print, but after a close scrutiny of the signal in question on the air, I was convinced that this was definitely not "state of the art" and left it in the file. On the request of W3PHL's attorney, the article was returned to him a couple of months ago. CQ then printed it in their July issue. I'm glad the egg is on Dick Ross' face, not mine. From the information I have been able to gather, the author has had his license suspended for, among other things, excessive broadness of signal. When a signal takes out over 15 kHz on a fairly sharp receiver, it has no justification in my book. Work whatever mode pleases you, but keep it clean and sharp.

A note to prospective authors. We are still eager to read your manuscripts and hope you will write about what you are doing. The August issue contained an article by Ken Sessions K6MVH entitled "Hamwriting" which should act as a guide to good writing. To assist further, pages 94-95 in this issue contain two charts giving all the electronic symbols used on schematics and the abbreviations used both on schematics and in the text. I would like to suggest that you keep these charts handy for reference when writing. You see, I am basically lazy and the fewer corrections I have to make to your manuscript, the better I like it.

. . . Kayla W1EMV

de W2NSD/1

Miller Confesses!

When word came that Miller had admitted the St. Peter and Paul Rocks hoax expedition I was relieved, but not really surprised. I was aware of a good deal of the evidence that the League had gathered against him in this and about twenty other of his operations. The PYØXA trip was of critical importance though since it was the *only* one where he had a surviving accomplice. I suspect that when Miller found that his accomplice was not about to chance imprisonment by lying under oath that he was trapped into confessing.

Where was he at the time he was claiming to be operating from the Rocks? Well, his license was running out and he didn't have time to get all the way down there to the middle of the Atlantic Ocean off Brazil, so he operated just off the coast of Venezuela, probably near Trinidad on board a ship and a good 1800 miles from St. Peter and Paul.

Miller has withdrawn his suit against the League and Huntoon and I expect that the suit against 73 and myself will be withdrawn shortly. Don't feel too badly if you were taken in by Miller and his stories. He is most convincing and audacious. If there is any rational reason for his doing the things he has done and acting the way he has acted, none of us intimately involved have been able to figure it out.

I understand that Miller's explanations for the other questioned expeditions were vague, contradictory and evasive. Proof of anything? Sorry, but most of the records have been lost or stolen. Passport? Lost that too, just recently.

The League would certainly seem, on the strength of the testimony given, to have adequate grounds for deleting credit for about twenty of Miller's operations. Pressure from DXCC members will probably force them to accept all but the most outrageous.

Where does this hoax confession leave CQ and their seemingly fictional series by Miller. How about the Miller DX book, promised about a year ago? Will CQ bring this out in the face of his disgrace? CQ has backed Miller to the hilt with their reputation . . . where does his confession leave them? Will they give us a public apology for the libelous attack on me they published for Miller?

If you have any friends who stopped reading 73 because I was writing bad things about their hero, you might pass along the word.

UFO NET SCHEDULE

Wednesdays 0200 GMT 14,300
Thursdays 0200 GMT 3950

Net Controls Needed

The UFO Reporting Net has been growing larger every week and now is much too large to permit all of the interested stations to check in. The net has been meeting on 14.3 MHz every Wednesday night at 0200 GMT.

Jim Sipprell K2HYQ has kindly consented to take on the organization of net controls for nightly operation of the net. The frequency will continue at 14.300 MHz and the time at 0200 GMT. If you are interested in acting as a net control one or two nights a week please drop a note to Jim. You should have a good signal and be dependable. Jim will pick out two for each night that are widely enough separated so they should be able to hear all checkins. We've found that we can get just about everyone with one control up east and one in the south . . . or one in the west and one in the south, etc.

If you can't be sure of being available on any particular night you should call into the net whenever you can make it. The net control stations will keep you informed on how things are going and will be interested in any reports you have to pass along.

To participate in the UFO Reporting Net you should set up communications with your local agencies that might get reports of sightings or would be interested in knowing of nearby sightings. You should talk with your

Turn to page 114

Going VHF - In The Mobile

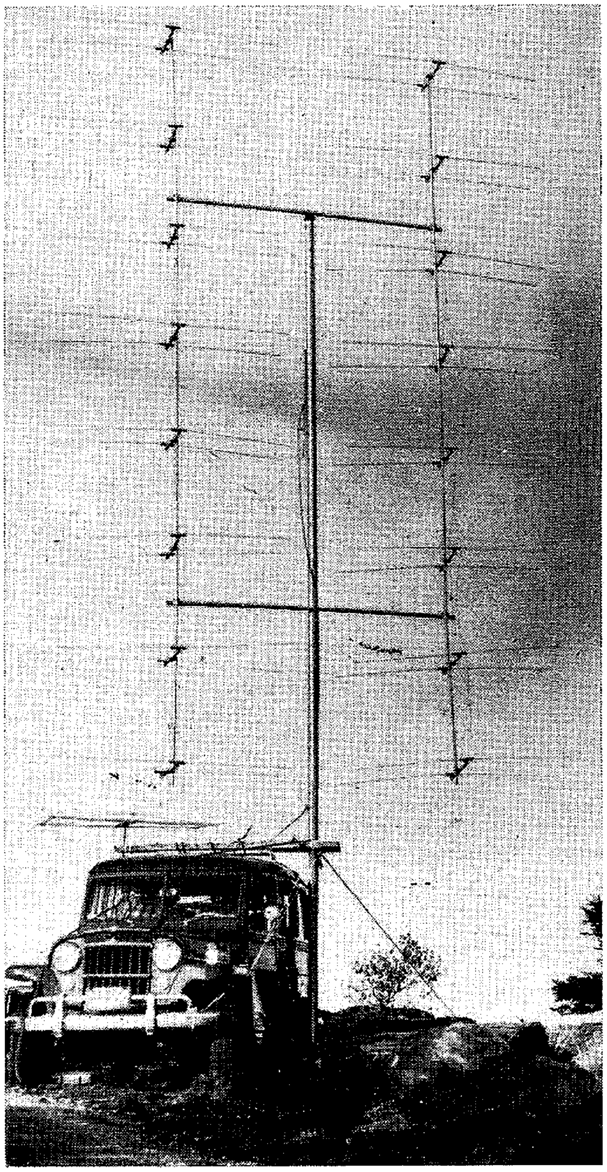
Robert M. Brown W9HBF
5611 Middaugh Ave.
Downers Grove, Ill. 60515

VHF mobileers claim it's the greatest — if you know what you're doing. This article outlines mobiling's role on the bands above 50 MHz, what you can expect, and some useful tips from the experts.

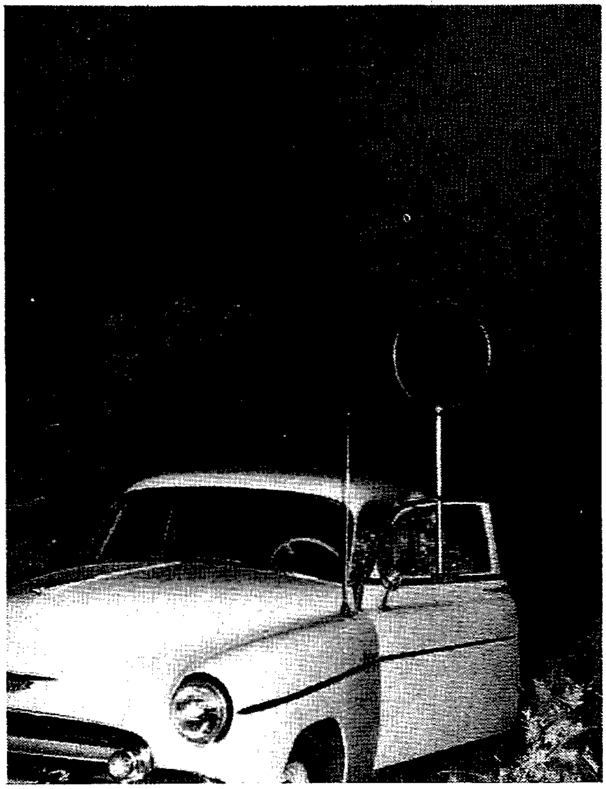
To the reader uninitiated in the fine art of exploring VHF from the auto, above 50 MHz mobiling may sound like a total waste of time. Indeed, there are thousands of low-frequency hecklers who'll tell you that (1) ignition noise is too severe, or (2) that there is never anyone on in your area, or (3) you'll be lucky if you can work out of town. The more experienced reader may claim just the opposite, if he answers these charges at all. Actually the truth lies somewhere between these two attitudes, for mobiling at these frequencies is altogether unlike operation in any other region of the amateur spectrum.

Where it all started

When VHF'ing was in its infancy scarcely twenty-five years ago, a few thoughtful tinkerers gathered together in various sections of the country to ponder a problem. How could these "experimentalist" frequencies be effectively employed for ham communications? Numerous tests had been conducted on VHF, but they had always been point-to-point affairs, and always prearranged. Results, published periodically in *QST*, substantiated the theory that 5 meters could afford amateurs something truly different, provided enough interest could be aroused. What these ambitious amateurs undertook was the construction of crude mobile rigs, many using single-tube crystal controlled transmitters and super regenerative receivers—others used tuneable converters and modulated oscillators, for operation on this "unexplored" band. Well documented in ham journals is the fact that these famed 5-meter mobiles were directly responsible for VHF coming into its own as an essential yet independent adjunct to the hobby.



For K2UYH, a frequent extension of mobiling is hilltopping, which is where our camera caught him recently. Antenna is a 32-element 144 MHz collinear, while at left (barely visible) is his 3-element six meter collapsible. Normally halo antennas are employed for in-motion QSO's.


Night time transmitter hunts are a favorite indulgence for anyone equipped for six or two meters during the summer. This photo was snapped during a Portland, Ore., hunt a few years back. (Hidden transmitter is 10 feet to the right of the antenna, well camouflaged in foliage).

Soon more sophisticated equipment began to appear, with superheterodyne receivers and higher-powered transmitters. The magazines encouraged the trend by publishing new circuits as they were developed.

By the early fifties the 6-meter band had emerged as a full-fledged extension of 10 meters, while war surplus gear put operators on 2 inexpensively. Civil Defense, no longer content to see all this going to waste, shifted its entire emphasis from 28 to 144 MHz. Literally thousands of cars sprouted whips, many equipped inside with Gonset Communicators purchased by CD. In 1952 the FCC passed an amendment permitting Technician Class ticket holders operation on six. Overnight signals appeared, bringing the 50 MHz band from relative obscurity to a mobileer's holiday. The "Mobile Sixers" was founded in Philadelphia while similar groups organized simultaneously from coast to coast.

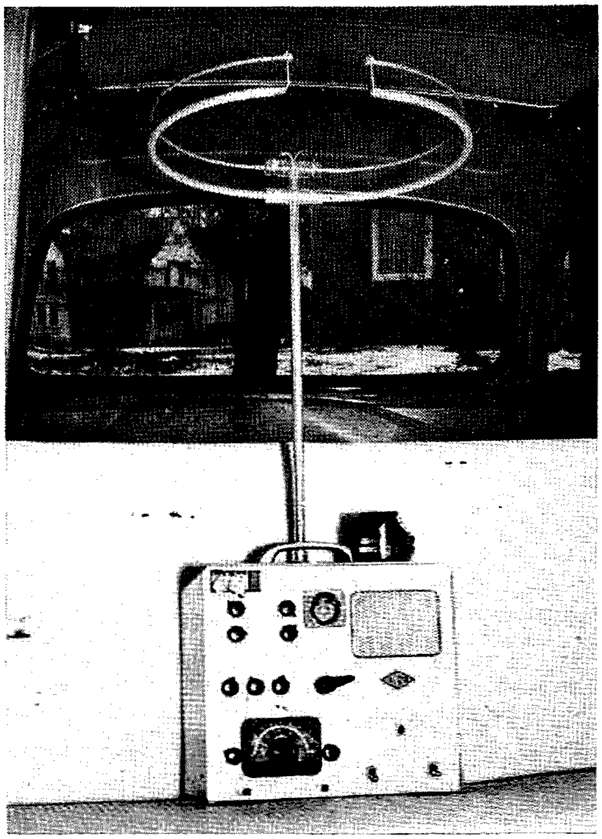
What is significant about this recent history is that without mobile participation and pioneering, these two VHF bands could hardly be what they are today. Additionally, the very highs developed in a reverse fashion from the lower frequencies, where base stations were initially what populated the ham bands. Why this extraordinary enthussiasm for six and two meter mobiling?

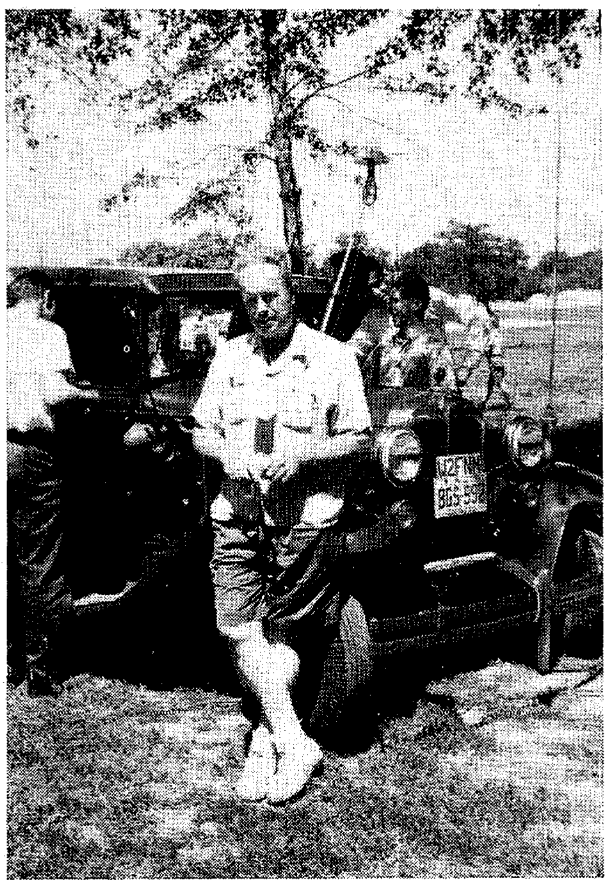
Perhaps because it *is* different.

144 MHz techniques

Because VHF mobiling is something unique in our hobby, to enjoy maximum success requires a bit of first-hand investigation. As many know only too well, you can't just put together a set that tunes 145 to 146 MHz, hook into the car radio antenna and expect results. Nor for that matter can you expect to install a vertical radiator on the bumper and start calling CQ on 50.78 MHz. Unless, perhaps, you live in northern Vermont.

At two meters, particularly, it is to your advantage to check local operating habits. The mobiles with the greatest number of QSO's are often those who belong to an on-the-air club or emergency network such as AREC. Why? Because base stations in many sectors are horizontally polarized, while mobile enthusiasts stick to their whips. To reach a happy medium necessitates


Though it might not look it, Arlo Nease, KN9HIH, claims he does quite well with his 144 MHz halo inside the Isetta.



A crowd always gathers around W2FNM's fire-engine-red Model A, "equipped for the works" (160 through 2 meters).

getting together with an active local and finding out his views on the subject.

Mobiling here can afford numerous short-range contacts providing a few basic facts are kept in mind. Most importantly, nearly all two meter stations are still crystal controlled. And they don't tune the entire band after each CQ. For you, it might seem like a small feat, but for a well-equipped base station it can be a physical impossibility to tune 144 to 148 MHz in anything short of ten minutes. For this reason it is a good idea to have several crystals handy if you're at 144.4 and he's tuning only "145 to 146."

Although 95% of two meter stations use AM, certain regions are populated only by hams using converted Motorolas, Links, GE's, etc. (all FM). By the same token the vertical/horizontal observation mentioned above can frequently be reversed! And to add to the confusion is the fact that the most-used frequencies in the band may vary from one state to another.

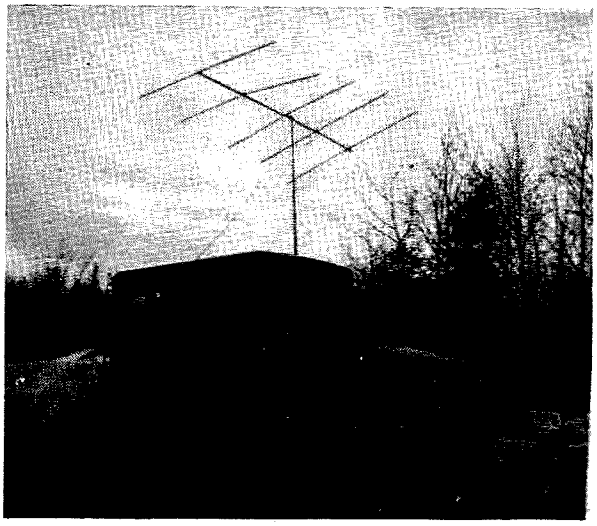
Dependent on whether you reside in a metropolitan or rural area, you can sometimes do quite well with super regenerative receivers like the still-popular Heath Twoer. While it may not be a dyed-in-the-wool v.h.f. DX'ers cup of tea, the super regen remains one of the most sensitive designs available, providing excellent reception in low-activity regions.

The "real" 2-meter mobile addict uses three antennas: a 19" whip, a single-element halo, and a collapsible 5-element yagi. Generally the whip and halo are interchangeable at the rig, while the yagi is for hill-topping. The more typical setup, however, is simply either the halo or whip.

At 144 MHz, height is an all-important factor. A good technique to employ when seeking a QSO is to begin the CQ while driving up an incline, such as the side of a hill or bridge ramp. Time your transmission so that your sign-off coincides with the peak of the hill or bridge. In reality this method inflates your signal several "S" units, just enough to catch another station. Once in contact, you'll find you can hold it satisfactorily even though you lose elevation. Since the other station invariably has a directional antenna, *he* does the work.

Another "must", while we're talking about narrow beamwidth antennas, is always to give your location. Nothing is more frustrating than to hear a mobile calling CQ, not know his QTH, and begin turning the antenna only to have him go off while you have him in a null. A good rule-of-

Here's a shot of the author (about four cars ago) making comparison checks between a Clegg Thor 6 prototype and a 99'er. A 50 MHz linear amplifier in the trunk, remotely controlled from the dash, aided immeasureably in shortening the life-span of this '53 Chevy.



Although mobile-in-motion QSO's are understandably short-lived, WA2VOI really racks up on mountaintops during VHF contests.

thumb here is that one location report with each identification will buy you what it would take three CQ's to secure otherwise.

Obstructions can be severely damaging to a 144 MHz mobile signal, since most *rf* reaches the base receiver by direct groundwave. Don't call CQ while trapped in downtown traffic between skyscrapers, or under an elevation. Unlike the lower frequencies, your S7 signal can virtually disappear in a matter of seconds. If you find that you'll be losing elevation soon, or that you'll be stuck under an overpass at a light, inform the other operator. He'll be only too happy to either kick in his preamp or stand by until you are in the clear again.

Flutter can be annoying at 2 meters if not approached properly. Rapid QSB can result from cross polarization (a common offender) and/or your fast-moving vehicle. But the most little-known cause that can be remedied easily is simply your car's position. Since wavelengths at two meters can be measured in inches, your proximity to metallic objects and buildings sharply affect your signal. If you are stopped and in QSO, inch the car slowly backwards or forwards while listening to the receiver. Always park exactly where the signal peaks if at all possible. Use this technique at stoplights also by prematurely slowing. When you see the signal begin to rise on the meter, take her forward by the inch. You may find this changes your driving habits considerably, but it is well worth the effort.

In open country two meters is loads of fun. By closely observing the "S" meter, you'll experience a phenomena seldom found at any other frequency. Buried pipelines, hidden rock formations and underground streams often inflate incoming and outgoing signals by as much as 45 db. The trick is finding the exact spot. When located, you can park, call CQ and wait for the pile-up. This is almost as much fun as mountaintopping, and even more when you inform your captive that you are 40 miles away, running 3 watts and practically at sea level.

The formula is all in keeping the receiver "on" whenever you take a drive. If you are out with the wife and kiddies, keep a watchful eye on the meter even though the volume is turned down. Make a mental note of your location should you see any sharp increase in signal strength that disappears rapidly as you pass. Then, when you are out alone, return to that spot.

Can you get real DX on two without heading for the hills? Certainly, but it takes some doing. By employing the same method outlined above, watch for sudden *and sustained* increases in signal strength in your high-speed driving. For example, a drive on the Pennsylvania Turnpike might net nothing, or the time of your life. It's worth keeping the rig on to find out. Should you get "caught" in a situation where you notice strong signals from an area you know to be unusually far away, pull over to the side and attempt your QSO. Don't continue on your way, for you've accidentally fallen into a *VHF* phenomena known as the "tropo duct." Like a pipeline, 144 MHz mobile signals can be "ducted" into certain towns up to 200 miles away for periods of time lasting only a few minutes to two hours. The peculiar thing about this condition is that stations five miles away won't hear a peep.

One final tip: If at all possible, install a SWR bridge in the feedline and mount it under the dash with your transmitter. Two meters is the only popular ham band where you'll be making a 2 MHz frequency jumps as a matter of course, and you'd be surprised what that will do to your standing waves! Cut the antenna for the middle of *your* operating range and arrange a tuning device for emergencies. More 2E26's have been blown by two meter mobileers than you'd care to learn about.

50 MHz techniques

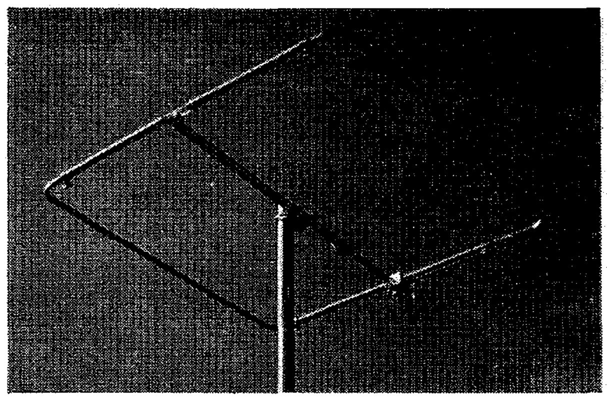
On six, the old "there's-something-for-everyone" adage is a fact, if you are prepared for it. Fifty megahertz mobiling has been termed a cross between 10 and 2 meters. Don't you believe a word ot it.

In reality six meter monitoring can be compared with no other. It's characteristics resemble no known amateur band; nor do its problems. Perhaps the most pressing annoyance is ignition noise, the cures for which have appeared in all major ham publications. Though not as severe as on the lower frequencies, this problem must nearly always be dealt with before you'll enjoy the true excitement and rewards of six meters in the car. Once this is out of the way, you'll want to spend 20 minutes with a coil of #12 wire and a trimmer capacitor to place a series tuned circuit across your generator. Careful adjustment with an eye on the "S" meter and the engine at full rev will null out your generator whine and you are ready for action.

Unlike two meters, you *will* need more than a few crystals, unless you have a well-regulated 8 MHz VFO handy. Putting yourself on 50.106 can be a tragedy or a blessing in disguise, depending on the weather, time of day and local whims. Most mobileers prefer the 50.200 to 50.500 range, although there seems to be an unwritten philosophy which says that the first operator on 50.250 won't be lonesome. But even this won't help you on a Saturday night or during a band opening, at which time you had better be either on a very high mountain or above 50.750 MHz. Confusing? The best is yet to come.

"Normal groundwave conditions" is a misnomer; one day you will get an S7 report from across the river, the next day an S5. Though your customary working radius is greater than on 144 MHz, it isn't necessarily as dependable. A multitude of variables such as humidity and temperature can drastically alter your average-range picture. To say nothing of Sporadic-E skip, which, depending on whom you consult, either extends or shortens your groundwave coverage.

The most noticeable difference, though, between mobiling on two and six is your calls-QSO ratio. Since few people really tune on six meters until after they've first checked their frequency, your calls-QSO ratio is directly proportional to your *proximity to him on the dial.*



A comparatively recent development, the Cush Craft "Squalo" has a loyal mobileer following among many six and two meter operators. The antenna, essentially a "square halo", affords an omnidirectional dipole pattern with compact physical dimensions and is available in models through 432 MHz.

But aside from these relatively minor calamities, you can have enough fun to write home about. When you find the neighbors XYL, and junior op's too much with their TVI complaints, you can delight the entire crew by hopping into the auto and steathily driving off to a new, unsuspecting sector, wreaking havoc as you cruise by. Which, incidentally, might be one of the contributing factors in the tremendous popularity of 6-meter mobiling in this country.

Operationally, it is advantageous on 50 MHz to first check your frequency (a spotting switch is a "must"), and then let loose with a CQ. Due to the concentration of stations in the first 500 kHz on this band, it is seldom necessary to call for more than one minute before tuning. A rapid check of the band thereafter, followed closely by a more careful tune, is also a good habit to get into. Never make a transmission without stating your approximate location unless you are a commercial radio announcer who likes to keep in practice during off-hours.

Unlike two, a good number of 50 MHz stations enjoy working weak-signal mobiles and attempting to hold them until the bitter end. This is important to bear in mind because you can unintentionally offend these long distance runners if your ignition noise overrides their calls, or if you are not in the habit of listening for threshold signals.

Another tip: Since most of your QSO's will be with well-equipped base stations, don't drag out your transmissions. He can

hear signals you can't, especially those on your frequency. If you find you have lost contact, standby for instructions. Chances are you'd fare better higher up the band, where QRM is not as prevalent. This technique can also be employed in reverse. To secure your QSO, give a call in the first 100 kHz of the AM band, establish contact, then QSY without waiting for the inevitable heterodynes.

Although only the rank newcomer to six meter motoring will have to be told that 95% of the stations are horizontally polarized, few recognize that installation of a CB-type whip can also be advantageous. Quite often switching to vertical polarization yields unsuspected rewards, particularly if your partner can do likewise when you are stuck on a busy frequency. If you're handy with plumbing, add another loop to a 3-ring halo and listen to the praise roll in. The additional ring, when the antenna is carefully adjusted for best-height-above-ground, frequently eliminates the "typical mobile flutter" that's usually a dead give-away to operators who don't like mobiles.

If you would really like something different, the next time signals take on that warbly aurora characteristic, head for the highest piece of land around and rotate the auto for a peak reading. Pick out the strongest CQ caller you hear, speak noticeably slower and more distinctly, and give him a shout. The old rule-of-thumb that you must have at least 100 watts into a 5-element array can be proved wrong if you are the persistent type.

The simplest way to pick up DX on six is, of course, through Sporadic-E skip openings. Big antennas and high power mean little. The trick is to get out of the QRM. Make it a practice to always keep a crystal for an odd frequency above 51 MHz handy for emergencies. It is a fact that mobiles invariably cash in first on long-haul skip contacts, probably because a six meter mobileer tunes a receiver with less bandspread than the base stations employ and therefore is one of the first to hear the higher frequency DX callers. Keep transmissions short, since E-layer openings are unpredictable and can take a turn for the worse in an instant.

The really ardent 50 MHz mobile operator employs both a v.f.o. and a nuvistorized preamplifier. Properly regulated supplies for stability and multiple-wavelengh feedlines for best SWR make for mobile fun you'd never dream possible. By spending 90% of my driving time *listening*, this writer picked up 34 states during a 6-month period not long ago, which, by the way, included five over-200 mile groundwave QSO's. This was accomplished with a 4.5 watts-output transmitter into a 4-ring halo.

Driving through open country, keep an ear out for the weak, out of state signals. If you hear a couple stations in QSO whom you know must be at least 75 miles away, throw your carrier on intermittently to create a "signaling" heterodyne. When they stand by for the breaker, do your stuff. If you've been listening for a while, instruct them *right off* to turn their yagis NNE, or whatever the approximated direction is. They'll never believe you're a mobile.

Be Different

We would be doing you a grave injustice if we did not include in this report the fact that numerous v.h.f. stations simply will not QSO mobiles. Their reasons are worth listening to, if you are seriously contemplating mobile operation: (1) They disappear into the noise before you've had a chance to make a transmission, or (2) They never say anything worth listening to, or (3) Their audio is inferior, or all three. There is much truth in these observations.

We can't stress often enough that you keep your transmissions *short* and to the point, seldom more than two minutes in duration. Let him do the talking; anyway, you have to drive.

Avoid confining your topics of conversation to such earth-shattering developments as a Mack truck has just pulled in front of your vehicle. Keep a scratch pad on your dashboard and *use it* to note what *he* is interested in.

If your audio really delivers, the other station won't care if you are an S1 on the meter. If it doesn't, invest in a CB-type transistorized speech clipper or compressor. They work, you know and are just about the best buys around.

By "being different" you can win over a lot of these soreheads, realize many hours of pleasureable mobiling, and have something you'll remember for a long time as truly worthwhile hamming.

. . . K2ZSQ

Communicator Reborn

W. R. Lingenbrink W6HGX
1809 Hill Ave.
Hayward, Calif. 94541

It is impossible to get single-signal-selectivity using a Gonset Communicator (Gooney Bird), but we can sure make some improvements in the selectivity of this "old faithful."

By making the receiver section double conversion, we have been able to eliminate interference from aircraft and repeaters close to the frequency and, in general, have been able to make the Gooney Bird sound like a converter working into a good receiver.

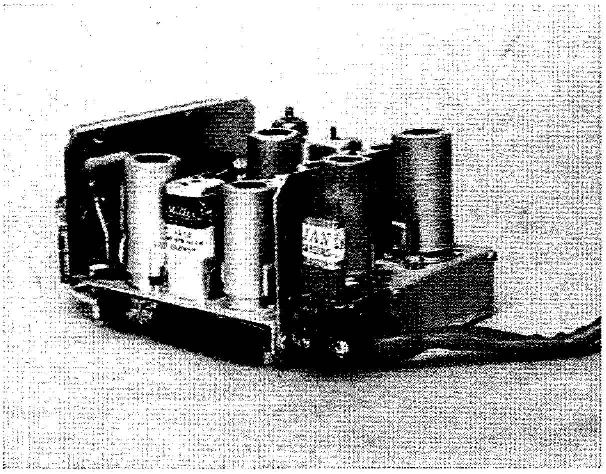
The cost is very moderate (less than ten dollars and about four hours of your time), and in addition no alterations show from the outside so there is nothing to detract from the resale value of the unit.

Looking at the receiver section, either out of the cabinet or at the diagram (if you are lucky enough to have one), we find several stages of six MHz *if*. If we make one of these stages a mixer and change the last two *if* cans to 455 kHz, we have a fine double conversion receiver. By adding crystal controlled local oscillator to our new mixer stage, we are in business. This local oscillator may be added as an outboard stage mounted on a bracket next to the pre-amp on the back apron of the receiver section as shown in **Fig. 1.**

The choice of oscillator tube may vary. I used the 6AV6 because it was on hand and has shown to work fine.

The bracket should be made and mounted in place before any wiring is done due to the difficulty of getting the mounting screws in place after the wiring is in. The oscillator is then wired as shown in the diagram and test voltages applied. Using a VTVM you should read about −2 to −4 volts at pin one of V11 (6BH6) which is our new mixer stage.

Now remove the last two 6 MHz *if* cans (T3 and T4) noting the position of the green dot on the bottom of the existing can so we can place the new ones in the exact position. Remove the wiring from the old *if* cans carefully so as not to shorten the leads any more than absolutely necessary.



This photo shows the oscillator mounted next to the pre-amp on the back apron of the receiver section. One of the new 455 kHz *if* cans can be seen in the center.

These leads will be used on the new 455 kHz *if* cans. I used the Miller "K TRANS" designated 12C1 and 12C2, input and output, since they are of the same size and mounting configuration as the ones being removed.

When the transformers are mounted and reconnected, the cathode resistor (R21) on our new mixer tube should be replaced with a 5 K resistor of the same wattage as the old 150 ohm one. This completes the conversion so check the wiring carefully.

Next, leaving the receiver section out of the case, connect the power plug to the transmitter modulator audio section and begin the line-up of our new *if* section.

When you turn the set on, don't be alarmed at the lack of VHF hiss that you are used to hearing. This will be back when the new *if* transformers are peaked. This can be done either on background noise or by using a noise generator. This process is described in all the handbooks, but it is sufficient to peak to the highest noise level.

When this has been done, you might be

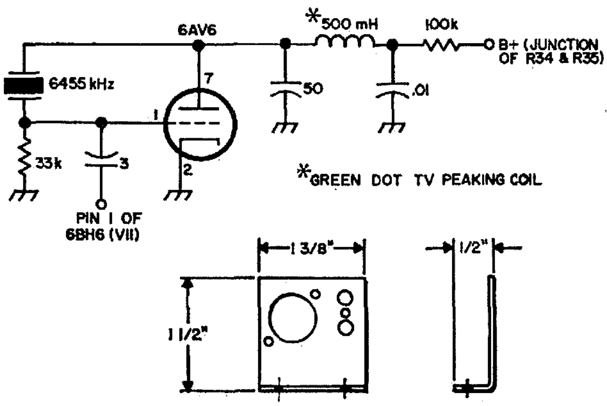


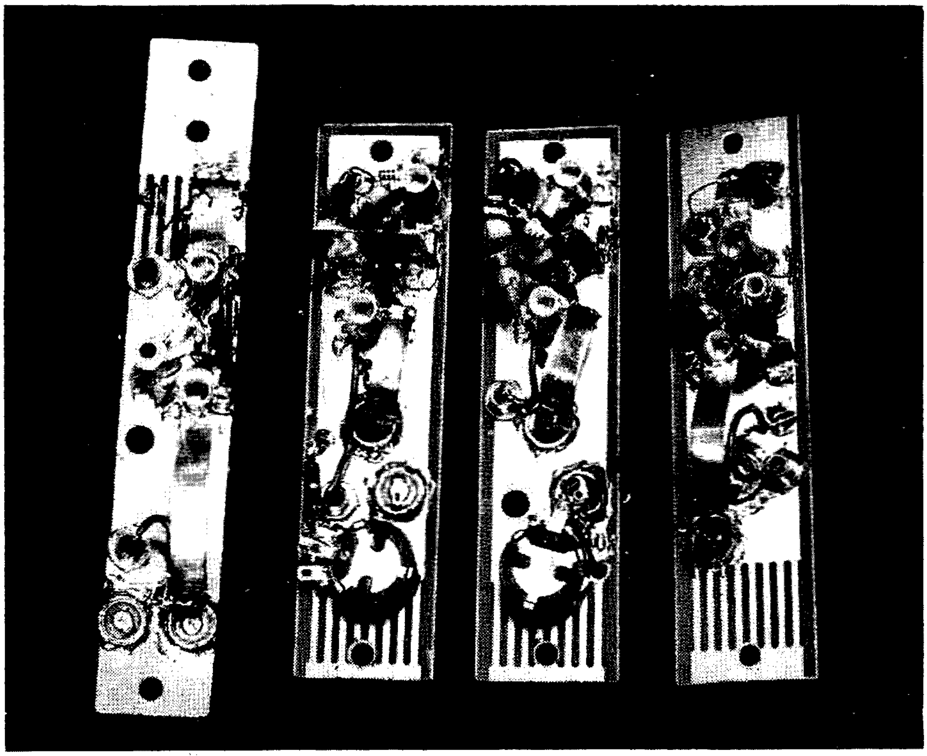
Fig. 1. The oscillator circuit showing the mounting bracket used.

interested in one other modification using low cost rectifier diodes. The replacement of the two 6X4 rectifiers in the power supply with solid state will yield about 25 volts more from the output of the supply and will eliminate a good deal of heat.

All inquiries will be answered if accompanied by a self addressed stamped envelope.

. . . W6HGX

"IS THAT ANOTHER ONE ABOUT TVI, GEORGE?"



Frank C. Jones W6AJF
850 *Donner Ave.*
Sonoma, Ca. 95476

432 MHz Amplifiers

The four different 432 MHz amplifiers, shown in the photograph and in the circuit diagrams, were built up on small strips of copper plated plastic board. The purpose was to run a series of tests on different kinds of FET units which might work on 432 MHz. The field effect transistors have come down in price and the three types tested all sold for approximately one dollar each. The three available at the time were the Motorola MPF 102, the Texas Instrument TIS34 and the Union Carbide UC 734. Both grounded-gate and neutralized grounded-source circuits were tried by either making up new strips or rewiring the existing strips. The four amplifiers shown in the photograph from left to right are ground-gate MPF 102, grounded-source TIS34, grounded-gate UC 743 and grounded-source UC 734 (or 2N4416).

The circuits consisted of short pieces of copper sheet from ¼ to 5/16-inch wide; 1 to 1½-inches long for the tuned input and output 432 MHz circuits. Low priced plastic piston trimmer capacitors of 1 to 6 pF were used to tune the circuits. These were connected by short leads, usually sheet copper, to the input and output terminals of the transistor sockets. In most cases a small copper shield was soldered across the socket to isolate the input and output circuits. The grounded-source terminals required at least two 300 or 500 pF disc capacitors with extremely short leads from socket to ground in order to "cool off" the rf stage in spite of a slug-tuned neutralizing coil. The latter had to be from 2 to 4 turns on a white-coded ferrite slug form, 3/16-inch diameter for the different FET units which ran from ⅔ to 1½ pF feedback capacitance. The coil and leads had to resonate with this capacitance to 432 MHz. It was later discovered that the neutralizing coil-form mounting screw should not be grounded since this makes it difficult to obtain correct input, output and neutralizing adjustments. Also, an insulated mounting (in the input compartment) allowed one more turn of wire on the form with wider bandwidth in the adjustments.

The 50-ohm input connection for either grounded-gate or source circuits at 432 MHz always seemed to work out at about the center of the input strap circuit, that is

midway between the tuning capacitor and ground ends of the strap. Apparently both types of circuits functioned at best noise figure with from 200 to 500 ohms impedance into either the gate or emitter terminals. The same circuit showed lower Q (less critical tuning) with emitter input, that is with the grounded-gate connection. This probably meant about 200 ohms input, whereas gate input needed around 500 ohms for best NF.

The output circuit was always adjusted for 432 MHz resonance, maximum gain, together with space variation of the output loop. Too close coupling gave low stage gain. The output loop from coax fitting to ground was made of number 18 wire in order to be able to vary the coupling to the drain tuned circuit, but, at the same time, to keep the coupling constant when in use as a preamplifier ahead of the regular 432 MHz converter.

The neutralizing coil in the grounded-source units was adjusted for the value which gave maximum gain without excessive regeneration in all cases. Actual rf oscillation even 2 or 3 MHz away from 432 MHz had to be checked by tuning the *if* receiver across several MHz since this will prevent proper operation of an amplifier. Noise figure and gain measurements were made on all amplifiers using several different transistors of the same FET types. A diode tube noise generator, partially compensated to work reasonably well at 432

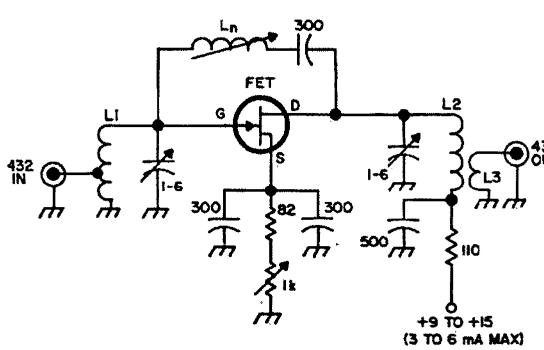


Fig. 1. Grounded source circuit for FET's.

L1 = 1" long x ¼" wide copper strip, center tapped.

L2 = 1½" long x ¼" wide copper strip.

L3 = Approx 1" of #18 wire coupled to L2.

Ln = 2-4 turns #22 wire ¼-⅜" long x 3⁄16" dia.

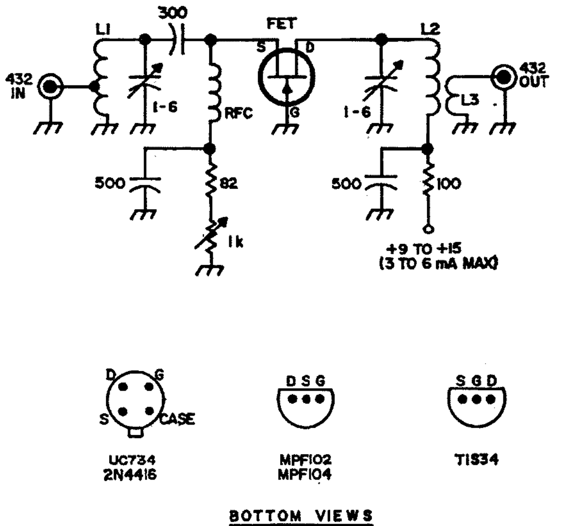


Fig. 2. Grounded gate circuit for FET's.
L1, L2, L3 as in Fig. 1.
RFC = 7" of #22 wire coiled up into solenoid.

MHz, was used for NF measurements. A standard signal generator with a 6 db UHF attenuator between the amplifier and signal generator output connector was needed to insure 50-ohm input impedance, and another similar attenuator was connected in the 50-ohm line between the preamplifier and the 432-MHz converter. The latter helped reduce regeneration in either the amplifier or the converter from spoiling the gain measurements.

The MPF 102 (also some MPF 104s) amplifiers gave very low gain figures ranging from 1½ to 2 times or about 4 to 6 db. The noise figures ranged around 7 or 8 db which wasn't too bad. The converter by itself had a NF of 3 db with a Union Carbide 2N4416 rf stage, a very hot five dollar FET unit. The UC 734 FET units are TO-18 metal-cased units with four leads exactly like the 2N4416's except that they are mass-produced without the many added factory tests made on the 2 N4416's. Therefore, the UC-734 costs about one-fifth as much—$1.10 in small quantities.

The TIS34 neutralized amplifier showed about 4 to 5 db for the best plastic cased units in the grounded-source circuit and with gain figures ranging from 6 to 8 db for the best units. There wasn't too much variation in units, with over 50% working very well at 432 MHz. The TIS34 grounded-gate amplifier was quite stable, required no neutralization and gave a NF of around 6

db and gain of 4 to 6 db. This type of circuit would be fine for a second rf stage in a converter with a "neutralized" grounded-source first stage, since two "neutralized" rf stages always seems to be full of oscillation problems. These TIS34 plastic units and the MPF 102 plastic units look similar but have different lead arrangements. Both require an in-line socket with three terminals, if a socket is used. A socket increases lead lengths and capacitances but sure saves time in comparing transistors of the same make. Unfortunately, the TIS34 seems to be hard to find at Texas Instrument distributors and outlets.

The UC 734 units, if selected for 432 MHz operation, were by all comparisons far superior to the other FETs. The gain figures ranged from 8 to 12 db in grounded gate, with NF of 4 to 5 db. Twelve db was the highest measured in a run of ten UC 734 units. About 50% were good for 432 MHz with 3 of the 10 being "red hot", fully equivalent to the best of the four 2N4416 units available for these tests.

The neutralized grounded-source UC 734 selected units gave NF of 2½ to 3 db and gain figures of 10 to 18 db. These amplifiers are a marvelous thing for weak signal 432 MHz reception. It takes a very good parametric amplifier with its tricky adjustments and high cost to do any better. Needless to say, these tests were time consuming since each change of transistors always seemed to require a little readjustment to arrive at best gain and NF. Usually best NF occurred at 3 to 5 mA drain current with a 9-volt battery supply. The source bias voltage should be higher for 12 or 15-volt supplies, but probably at these same current values, since FET units are quite a bit like tetrode tubes.

In conclusion, the Motorola MPF 102 units are not very good at 432 MHz since this is too high a frequency for these general purpose rf and *if* transistors. They seem to be readily available at the larger Motorola dealer outlets at present for 90¢ to $1 in small quantities. The Texas Instrument TIS34's are fine at 432 MHz but at the time of these tests, are difficult to find at TI outlets (priced about $1.10 each). The Union Carbide UC 734 units, if selected, are real fine transistors for 432 MHz. These little gems are replacing all other transistors in my converters since they are far better than the best bipolar transistors that I've been able to obtain. At the time of these tests single UC 734's were $1.10 and about 75¢ in quantities of 100 and in very good supply. The poor ones at 432 MHz were all less than 2 db NF at 144 MHz, so none were wasted!

. . . W6AJF

**The specifications for I_{GSS}, I_{DSS} and g_m are relaxed slightly; capacitance and frequency specs are the same as for the 2N4416. ed.*

Quick Converters

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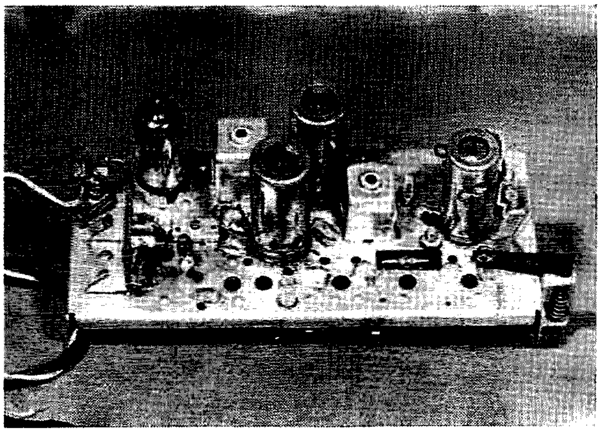
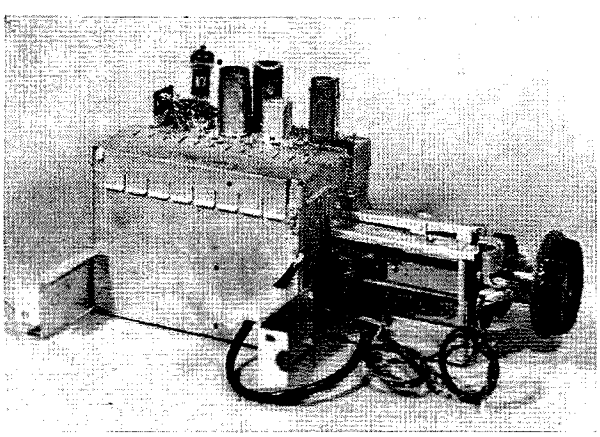
Recently I wanted to listen in on two meter activity, preparatory to going mobile. In order to do this I needed a converter to use with one of my station receivers. Naturally, I wanted it in a hurry and at minimum cost. A review of the ham magazines and handbooks disclosed several designs for good looking converters but any of them would have required mail order parts and considerable construction time. My next move, of course, was to open a catalog and price the commercially-made gear. The fine print associated with most of them said, "Specify *if* Frequency", indicating that they might not be on the dealer's shelf but made to order. So I asked myself, "How can I get one *now?*"

After thinking about this one for a while I realized that the front end or tuner in every TV set is essentially a converter. I immediately began to disassemble an old TV set that I had been saving for parts salvage and I found a very promising tuner. Incidentally, a few weeks later I made a trip to my friendly TV dealer to see what the "market" might have to offer other hams. I learned that used TV sets, in whole or in part, can sometimes be had for the asking. In fact, I came away with a twin to my first tuner.

As soon as I had scrounged the first tuner I did some research into the industry standards for TV channels and the associated receiver design. I learned that TV broadcast channels are assigned in four segments of the radio spectrum that lie between 54 and 890 MHz. Each channel occupies a total bandwidth of 6 MHz. The picture carrier is 1.25 MHz above the lower band edge and the sound carrier is 4.5 MHz above the picture carrier (0.25 MHz below the upper band limit). The current practice in the industry is to arrange the TV set tuner to convert the incoming TV signal to the receiver's nominal i.f. frequency of 41 MHz. (A few tuners may still be found that have an *if* at 21.5 MHz.) This is accomplished by operating the local oscillator 41 MHz above the upper band edge. The following relations exist:



The circuit deck as it appeared before the removal of the fine tuning assembly, power wires, and the 300 ohm input jack.



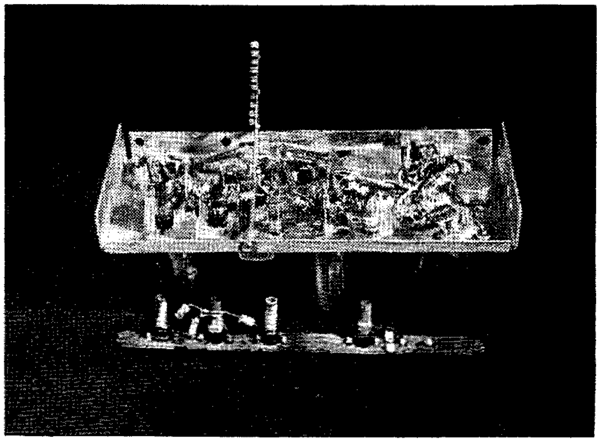
This is the way the tuner looked as it was removed from the TV set. It covered 16 channels, VHF and UHF.

Channel number	Occupied r.f. band	Picture Carrier	Sound Carrier	Tuner Local osc.
2	54- 60 MHz	55.25	59.75	101
3	60- 66 MHz	61.25	65.75	107
4	66- 72 MHz	67.25	71.75	113
5	76- 82 MHz	77.25	81.75	123
6	82- 88 MHz	83.25	87.75	129
7 to 13	174-216 MHz	*	*	221-257#
14 to 83 (UHF)	470-890 MHz	*	*	517-931#

*The carriers have the same relative positions in each of the channels.
#At intervals of 6 MHz.

The frequency of a signal at the output of a tuner or converter is equal to the *difference* between the frequency of that signal and the frequency of the local oscillator. (The sum of the two could be used but that would usually result in an inconveniently high fre-

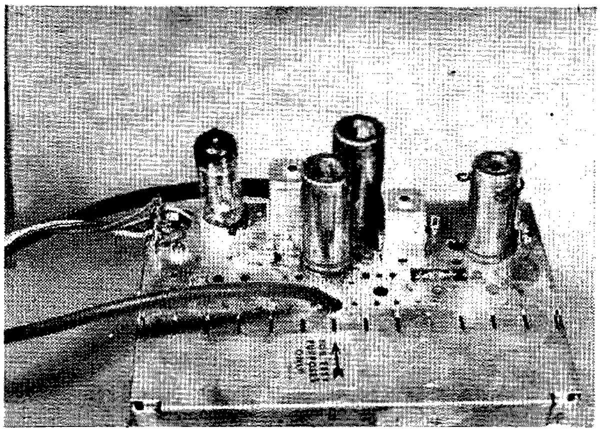
quency for use in receivers). Note that with the local oscillator *above* the incoming signal, the output of the tuner is inverted. That is, with two signals coming into the tuner, the one at the higher frequency will be translated to the lower of the two frequencies at the tuner output. At the tuner output, each TV channel will occupy a 6 MHz band extending from 41 to 47 MHz; The picture carrier will be at 45.75 MHz and the sound carrier will be at 41.25 MHz. Other signals may also be present as most tuners have a bandwidth of at least 8 MHz; both adjacent-channel and image signals will be present. Two other points are significant: The *if* transformer(s) in tuners are designed as broadband devices and will remain so even though you attempt to peak the primary and secondary windings at the same frequency. Most tuners make no attempt to amplify incoming *rf* signals in the UHF band, utilizing from one to three tuned circuits as a bandpass filter between the antenna and the mixer.



The rf coils are shown cemented to the chassis. One of the original channel tuning strips is shown for comparison.

Designing the converter

Two decisions that will have to be made regarding the converter involve the amateur band that you want it to accept and the frequency range that you want that band to have at the converter's output. Operating convenience will be greatest if the output frequency bears some direct relationship to that of the band on which the converter is used, for example:



Outwardly the tuner/converter shows only a little change in its interim state.

Amateur Band	Bandwidth	Convenient converter outputs
21.-21.45 MHz	0.45 MHz	X.00-X.45 MHz (X = any whole no.)
28.-29.7 MHz	0.70 MHz	8.0-9.7 MHz, 18.0-19.7 MHz
50.-54. MHz	4.0 MHz	10.0-14.0 MHz, 20.0-24.0 MHz
144-148 MHz	4.0 MHz	4.-8. MHz, 14.-18. MHz, 44-48 MHz*
220-225 MHz	5.0 MHz	10-15 MHz, 20-25 MHz, 40-45 MHz*.
420-450 MHz	30.0 MHz	See text.

*If your receiver will tune over this range you will not have to modify the i.f. transformers before use.

The converter output frequency should be chosen to fall within the tuning range of your receiver, should be covered without switching bands, and preferably without tuning the receiver across any strong local stations. The outputs listed above assume that you will use a fixed local oscillator in the converter. If a variable local oscillator is used, you might want to consider a conventional *if* frequency such as 10.7 MHz, for which commercially-made transformers are available, or 4.5 MHz, and use the sound *if* transformer from the TV set. If you plan to use the converter between 420 and 450 MHz then you can cover the band in segments by employing a fixed local oscillator and a broadband *if* or you can make the local oscillator tunable across the entire band and use either a broad or a narrow *if* system at any convenient frequency.

As indicated above, you will have a choice of using either a fixed or a variable local oscillator; you may also elect to use either a narrow or a wideband *if system.* Your decision will depend on the band you want to cover, the tuner that you are converting, and your station receiver. Several combinations are possible. I won't attempt to describe them all; it will be more helpful if I show how I made my decisions.

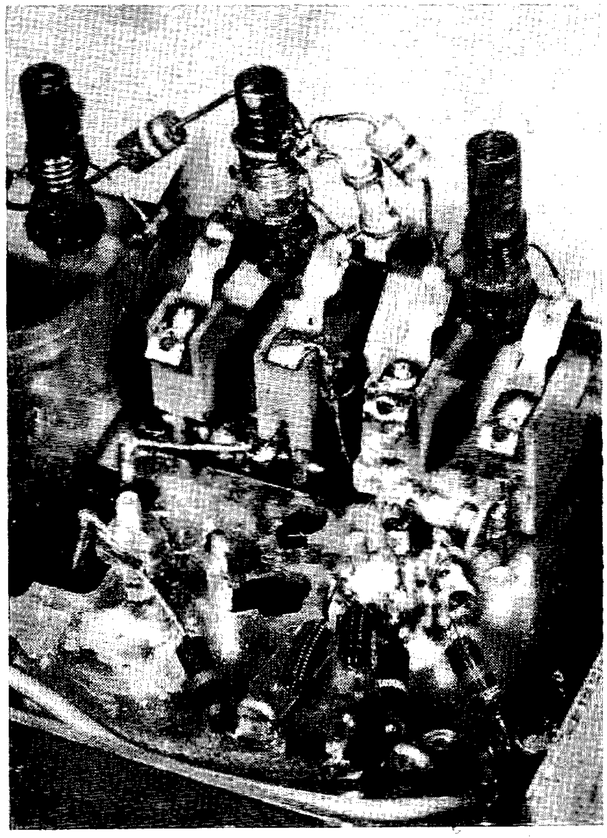
The two meter conversion

My objective was to build a converter to receive the range of frequencies from 144 to 148 MHz. One of my station receivers (an ancient S-36) would tune from 27 to 144 MHz in three bands. I studied the tuner that I wanted to convert. I found that it employed a 6BQ7A cascode *rf* amplifier and a 6S4 local oscillator, both of which fed a 1N82 crystal mixer. The mixer was followed by a second 6BQ7A *if* amplifier which also used a cascode circuit. A 6S4 was used to stabilize the plate voltage supply to the local oscillator. Taken all together it made an excellent line up for use as a converter.

After studying the tuner's construction and its schematic diagram I decided on the following course of action: I would retune the *if* transformers higher in frequency by 2 MHz (from 41-47 MHz to 43-49 MHz) and I would use a fixed local oscillator working at 100 MHz. This would result in the two meter band being converted downward by an even 100 MHz and the frequencies coming into the receiver would be directly related to their position in the band. For example, 144.5 MHz would become 44.5 MHz, 147.3 would become 47.3, etc. It was at this time that I decided to eliminate the existing fine-tuning mechanism, change the input from a 300-ohm balanced to a 50-ohm unbalanced configuration and to use 300-ohm twinlead to connect the converter to the tunable receiver. I noted (for future reference) that this particular tuner provided no amplification on the UHF bands. I also discovered that normally active overtone crystals would oscillate if connected in place of the local oscillator coil.

It was less than an evening's work to disassemble the circuit deck and the coil turret to the extent necessary. My plan was to get filament and plate power from the tunable receiver. This was done by making up a cord and plug to match an octal socket that was provided on the receiver for the connection of external power. I discovered an idle contact on the socket and found that it could be used to make the receiver's agc voltage available to the converter. I suggest that if you do not do the same thing, you may want to provide some sort of bias voltage for the converter. Most of them require a bias voltage of from −1 to −3 volts; it is usually supplied by the TV set's agc system.

I also removed the assemblies of fingers that made contact with the channel strips in the turret. I found that one of them had to be left in place, however, because the mount for the mixer diode was an integral part of it.



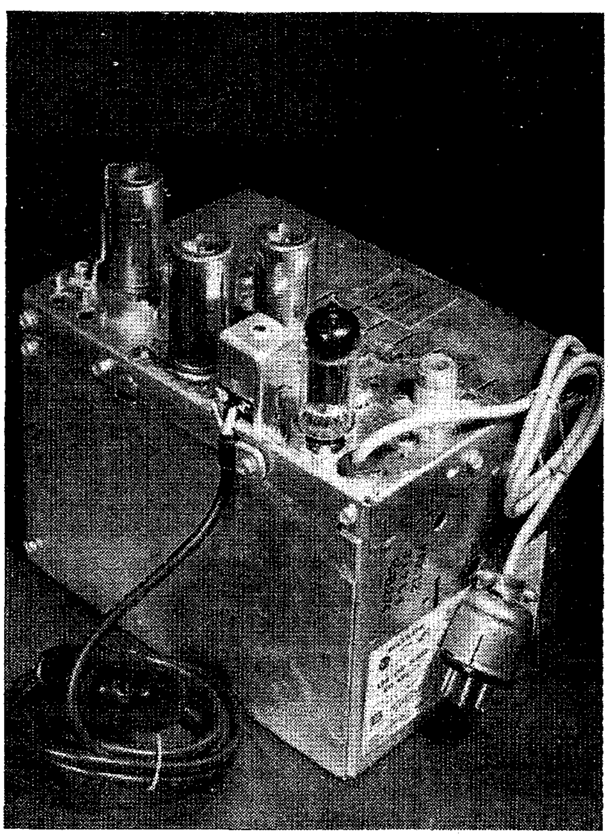
The rf mixer and oscillator coils are shown supported by their leads near the tube socket. The mixer diode is visible through a hole in the chassis.

In the second evening I was able to replace the *rf* coils so as to put the converter on two meters. The first operation was to remove the local oscillator coil from the tuning strip for channel #2. It normally works at 101 MHz and so it could be used without change. The tuning slug in the coil will easily change the frequency of the circuit by the required amount. Next I removed the *rf* coils from the tuning strip for channel #7 (174-180 MHz); they were soldered in place and adjusted to resonate in the two meter band. A grid-dipper was a big help in that work. Positioning the coils the way that they are shown permits them to be adjusted with a tuning tool inserted in the normal way from the top of the chassis. The final step was the connection of the input and output leads and the connection of the converter to the receiver. The *rf* coils peaked rather broadly, of course, but I was pleased to find that I had a working con-

verter that had a noise figure in the range of 6 to 7 db and a voltage gain of over 90. During the several weeks of operation that followed, my only criticism of the converter was that the local oscillator frequency was affected by mechanical vibration and that the whole assembly lacked the finished appearance of commercially-made equipment.

Gilding the lily

As indicated above, I originally went into this project with the idea that I was building a temporary piece of apparatus. The initial results convinced me that with a little more work I could have a converter that would be a permanent asset to my station. I considered such improvements as a crystal oscillator and *rf* coils made from commercially-built inductor stock. A crystal at 33.33 or 50.00 MHz could easily be obtained but I was concerned about having to filter out all but the 100 MHz harmonic from the mixer if I was to avoid spurious responses in the receiver. I also decided against high Q inductors as they might result in too narrow a bandwidth to cover the entire two meter band.



The finished tuner/converter presents a fairly respectable appearence. What was formerly the rear has become the "business end."

My final decision was to use the *rf* coils from a channel tuning strip for channel #6. These coils, together with the local oscillator coil, were cemented directly to the chassis to improve the converters frequency stability. The coils were brought to resonance by removing several turns from each one. I found this to be easier than using the coils for channel #7, as described earlier. The flexible contact fingers were broken off their supports and the coil leads soldered directly to the rivets that had secured the fingers. A type "N" coaxial connector was mounted on the chassis to function as an antenna input jack. One of the FM band rejection filters, previously removed from the 300-ohm antenna input circuit, was connected between the input jack and the antenna winding on the *rf* input coil. I also changed the 43 MHz output lead to coax, terminating it in a plug that would mate with the antenna terminals on my receiver.

The original power leads had been connected to an exposed terminal strip on the top of the chassis. I removed the terminal strip and ran a four conductor cable into the chassis through a rubber grommet. The free end of the cable was terminated in an octal plug that was arranged to mate with the "external power" socket on the back of the receiver, picking up heater, plate and agc voltages. I recommend my approach to anyone who wants a converter in a hurry or would like the pleasure of building something worth while out of practically nothing. My cash outlay was exactly zero, since all of the required cables, plugs, etc. that were not a part of the original tuner came out of my junk box.

I find that there is a pretty fair amount of activity on two meters around Chicago right now, but I wonder what the gang are doing up on 420 MHz. Lets see now; I still have that second tuner W9NLT

So You Think You're on Frequency

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In at least one area of the United States a quiet war was recently waged by two separate and very active amateur groups. One of these groups is a two-meter RACES net operating on 146.84 MHz AM; the other is an FM channel in 146.82 MHz. The malcontent stemmed from the fact that individuals of both groups had frequently found themselves transmitting simultaneously on a single frequency. Not unnaturally, each person thought the other had drifted off his original frequency.

The AM net operator, just to be on the safe side, double-checks his crystal and verifies that he has the correct one inserted. He wants to lean over backward to be fair. He cursorily checks his transmitter stages to make sure all are properly functioning. Everything checks out. His crystal is plainly marked 146.84 (or some integral multiple thereof). He wonders why those FM operators don't realize their frequency errors. And the wonder eventually turns into a smouldering suspicion that perhaps the FM hams who purport to operate on 146.82 are deliberately interfering with the net. A strong accusation, but still . . .

The FM'er is crystal-controlled on 146.82 MHz. At least once each week he must suffer through the erratic squelching, garbled voices, and foreign carriers that stagger across his sacred channel as the AM hams check into their .84 net. He watches his bobbing, frenzied discriminator from time to time during check-in and cringes when he thinks of how much spectrum those stations consume, taken collectively. With disdain that nearly always turns to hot agitation, he notes that those net check-in stations may transmit anywhere between 146.81 and 146.87 MHz. But from experience, he knows that each check-in station—if challenged—will take an oath to being on 146.84. The FM'er has tried to explain the telling honesty of his discriminator meter to the AM stations in the past, but he's long since given it up as hopeless. The AM net operator is crystaled on—and everyone knows crystals don't lie!

So this is the biggest point of contention: To the net operator, 146.*84* is whatever the signal is when the crystal is cut for .84 operation. To the FM station, 146.82 is wherever the signal is when the discriminator meter reads zero. The very honest fact is that the FM'er knows something the AM net check-in station probably doesn't: A crystal is NOT an absolute frequency-determining device.

The FM'er's crystal probably cost him around seven dollars; it was *specially ground for the circuit in which it is used.* The crystal manufacturer calculated circuit capacitance and other factors *based on this individual circuit information* to make sure the crystal would put the operator squarely on his "channel." Conversely, the AM station's crystal was probably cut without regard to the peculiar circuit parameters of his individual oscillator. As likely as not, his was originally a military crystal intended for use in an oscillator with a load capacitance of 32 pF. Or perhaps a commercial crystal intended for use in a 20 pF circuit.

Most amateurs aren't even aware of the differences. Most of us don't even know what type of oscillator our transmitters are using, let alone the load capacitance of the crystal circuit.

Whether or not the FM stations were at fault or the RACES net check-in stations were operating off frequency is really immaterial. What *is* important is the fact that a crystal *is not* an absolute frequency-determining device. This may come as something of a shock to bandedge operators who've been thinking they were safely operating all these years because they were crystal-controlled. There are a number of hams who say nasty things about crystal companies after they've been cited for off-frequency operation. But the crystal outfits aren't to blame. If there is

blame to be placed, it must rest at least partially with the amateur himself.

The frequency stability and electrical behavior of a crystal may be considerably altered when the crystal is used in a circuit other than that for which it was intended. So what about all those FT-243's, you ask? What, indeed; they're no exception! It is the responsibility of the amateur to know his own frequency—and that means knowing something about the crystal he's using as well as the oscillator circuit.

Have you ever listened to an active net with a selective receiver? If so, you've probably wondered how so many close-tolerance crystals could be on so many different frequencies. Again, as likely as not, the fault may lie not so much with the crystal as with the circuit. Some oscillator circuits "pull" crystals to such an extent that the actual operating frequency may be as much as 20 kHz off the intended transmitting spot.

The crystal

In many ways a good crystal is like a poor hi-fi speaker. They are both transducers, for instance, that have the capability of converting electrical energy into mechanical energy (and vice versa). Both have resonant frequencies where they will react more freely to the induced energy. A poorly designed speaker will react violently to input signals near the resonant frequency, and will tend to "boom" as the signals approach this resonance. A well-designed crystal yields a reaction that is similar in many respects. As the induced ac voltage across the crystal approaches resonance, the quartz element becomes very stable and will tend to exhibit a high degree of activity.

For communications applications, there are two common types of crystals in general use. One is the plated type, the other is pressure-mounted. In general, the plated type is superior, but both have the ability to maintain a very high degree of accuracy on their established frequencies.

This is not to say that crystals can't be wrong, themselves. They can—and very often are! But a good crystal of the plated type, furnished by a quality-conscious manufacturer (such as Sentry or International) will very likely be *right.* Crystals that go wrong are usually the pressure-mounted types—the FT-243's that depend on stored energy from a mechanical spring to hold them in position. The surplus FT-243 crystals are very vulnerable to frequency change because of the possibility of positional shift between the crystal blank and the pressure electrodes, and because of gradual—perhaps even imperceptible—pressure changes.

But even if surplus pressure-mounted crystals were perfectly error-free, the problem of off-frequency nets would still exist.

Oscillator parameters

The two prime determinants of actual oscillating frequency are crystal current (drive level) and oscillator load capacitance. If you order a crystal when you're not sure of these factors, you will have no way of knowing how far off frequency you're going to be.

The most universally used value for oscillator load capacitance seems to be 32 pF; most first-rate crystal companies supply crystals to this value when the load capacitance is not specified by the buyer. But the 32 pF value is by no means restrictive; a large number of equipment manufacturers design oscillator circuits with widely varying capacitance requirements.

Most commercial and military two-way radios are designed with a variable capacitor in the crystal circuit so the crystal can be "bent" to frequency once it has been installed in the oscillator circuit. This seemingly important feature, for some unknown reason, is not usually included in amateur transmitters.

The table below shows the actual operating frequencies of a crystal cut for use in a 32 pF circuit of a parallel-resonant oscillator. The first column shows the actual design frequency (which is the end frequency when the crystal is used in the proper circuit). Note how the frequency drops as the load capacitance increases. The last column shows the resultant frequency of the crystal when used in a series-resonant circuit. (Although admittedly not particularly common, series-resonant circuits do appear in amateur transmitters from time to time. The old Black Widow line of VHF transceivers and Robert Dollar units used circuits of this type. At 50 MHz, the Black Widow operator was always about 10 kHz below the rest of the gang.

It should be noted that series-resonant circuits are not necessarily inferior to parallel-resonant types; the important point is that

their requirements are different. In a series-resonant oscillator, the crystal is in series with a resistance. The crystal appears resistive, and load capacitance is no longer a determining factor with respect to frequency of operation. But unless the crystal is ordered specifically for a series circuit, the user will probably find himself considerably lower in frequency than he'll want to be.

In parallel resonance, the crystal is placed in series with a capacitance, so it appears as an inductive element to the external circuit. Any change in circuit reactance will affect the frequency of oscillation. This mode is of characteristically hig impedance and the resulting frequency is higher than that of the series-resonant crystal. The frequency of the crystal may be lowered by increasing the series capacitance or raised by decreasing it.

What can you do?

While I was preparing this article, I wrote to Sentry to obtain permission to use some of the information contained in the technical section of its 1968 catalog. In answering my letter, Mr. George Beyers, president of Sentry Manufacturing Company, said that his company is anxious to supply on-frequency crystals as most amateurs are to receive them. He said his company would be happy to correlate the frequency of a crystal circuit if enough information were made available in each case. So that provides you with at least *one* way to be certain of your frequency: if you want to operate on a specific frequency and you haven't ordered your crystal yet, you're in good shape. Determine the fundamental crystal frequency range, the desired operating frequency, then make a copy (even a sketch will do) of your oscillator schematic. Send the information to Sentry and wait for your crystal to be returned by mail. You can rest assured it will be exactly on frequency.

If you have no frequency-measuring equipment, but a known-to-be accurate signal is available, you can vary your existing crystal capacitance until you zero-beat the known signal. This is a particularly useful solution for a group of amateurs who participate in net activities. Netting several stations to a given frequency is a project that requires very little time, but one which is particularly rewarding for those who must monitor the net with narrow-bandwidth receivers. Adjacent-frequency stations will also be appreciative, you can be sure. These operators may position themselves far enough away from a net that the two concurrent operations could easily be accomplished. But the off-frequency check-ins always seem to find their mark; and the result is the same as it was in the case of the FM channel versus the RACES group: hard feelings and unnecessary animosity.

Varying the crystal capacitance to a frequency adjustment may be accomplished by replacing the load capacitor (between one side of the crystal and ground) with a trimmer. The original capacitor value should fall approximately in the center of the trimmer's range. In some oscillator circuits, the fixed capacitor that must be replaced is across the crystal itself. The proper capacitor won't be hard to find, in any case. A little experimentation should yield fruitful results.

Measured Crystal Frequency at kHz at:

32 pF Load	15 pF Load	40 pF Load	100 pF Load	Series Resonant
1000	1000.125	999.975	999.915	999.865
3000	3000.625	2999.880	2999.565	2999.315
5000	5001.325	4999.730	4999.020	4998.225
7000	7002.225	6999.525	6998.250	6997.250
9000	9002.835	8999.400	8997.800	8996.500
13500	13503.800	13499.270	13497.250	13495.750

An objective observer viewing the cold war that brewed between the two closely spaced net activities on 146.82 and 186.84 MHz might smile with grim amusement. But to those participants, the problem was real and serious. Fortunately, the frequency-netting solution is simple and easy to effect. It's really a wonder someone hasn't thought of it before! . . . K6MVH

Parallel-T Network Design

Jim Kyle
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Oklahoma City, Okla. 73111

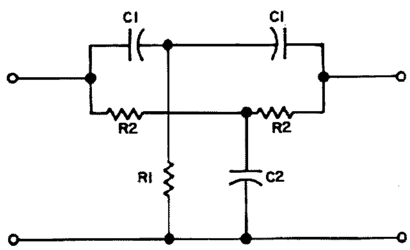


Fig. 1. The Parallel-T Network.

The Parallel-T network (**Fig. 1**) is a little-known RC circuit which produced infinite rejection of one specific frequency provided that resistance and capacitance values in it are properly chosen. This rejection property makes the network valuable for use as a lightweight low-current power-supply filter, for removing unwanted single-tone signals from amplifiers, and for use in feedback networks to produce oscillators and selective amplifiers.

Values of R1, R2, C1, and C2 are all inter-related, and will determine both the frequency of infinite rejection (f), and the sharpness of the rejection notch. Most published data on the Parallel-T treats only the case where R2 is twice the value of R1, and C2 is twice C1, but in actuality any set of relationships which will satisfy the following three equations at the same time will function as a Parallel-T:

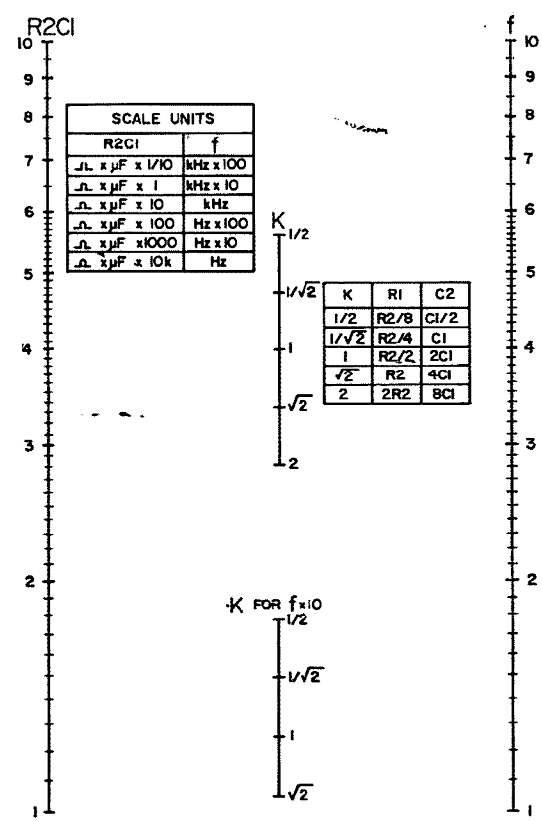
$1/wC1 = KR2$; $2R1 = K^2R2$; and $2/C2w = R2/K$.

(In these equations, K is a constant which determines the proportions of R1 to R2 and C1 to C2, and w is equal to $2\pi f$. If f is in cps, R1 must be in megohms if C is to be measured in microfarads).

The algebraically inclined can solve these equations to learn that the most-published version of the Parallel-T is that for a K of 1. However, if $K = \sqrt{2}$, or 1.414, so that R1 and R2 are equal, the slope of the sides of the rejection notch will be steeper. Versions published for use as audio notch filters consequently are usually based on a K of 1.414.

The accompanying nomogram can be used to solve the Parallel-T equations for any desired values of K and f, to an accuracy of better than 2 percent. The result is a product, R2C1, which in turn determines the values of all components. Either R2 or C1 may be chosen to be any desired value, and divided into the product to learn the value of the other. The table in the nomogram gives values of R1 in relation to R2, and C2 in relation to C1, for all listed values of K.

For instance, to determine proper component values for a Parallel-T to operate at 1000 Hz, with a K of 1.414, and a value of 10,000 ohms for R2, first draw a straight line on the nomogram to pass through 1000 Hz and K = V2. Either the 1 or the 10 on the f scale could be used, but the 1 mark (together with the "X 10" K scale) will give greater accuracy. This line passes through 1.10 on the R2C1 scale. To locate the decimal point properly, note that the frequency-scale units were "Hz X 100" (the added X10 multiplier was obtained by using the "X 10" K scale). Reference to the



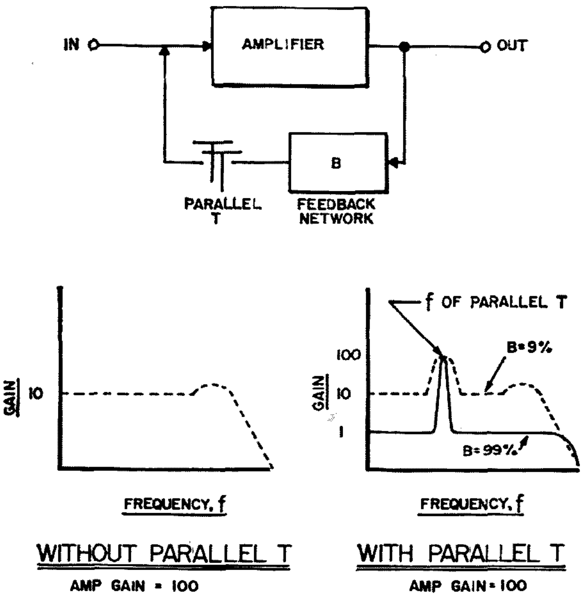


Fig. 2. A parallel-T in series with the feedback network of a degenerative amplifier.

chart shows that in this case, R2C1 is in *ohms x microfarads* x 100 so the true value is 110 *ohms x microfarads*.

Next, divide the R2 value of 10,000 ohms into the R2C1 product of 110 to determine the value of CI. In this case, it is 0.011 mfd for C1 (in practice, one 0.01-mfd and one 0.001-mfd unit would be connected in parallel to make up the total value). The table shows that with a K of $\sqrt{2}$, R1 equals R2 and would be 10,000 ohms also. C2 equals four times C1, or 0.044 mfd.

The actual choice of K and R1 is based on several considerations, which vary depending upon the purpose to which the completed network will be put.

For use as a power-supply filter with the rejecton notch placed on the predominant ripple frequency, the important considerations are to keep the total series resistance (twice the value of R2) at a minimum and at the same time to minimize the capacitance requirements. These considerations are contradictory. A K of 1.414 will minimize the value of R2, but a value of 1 for K will minimize the total capacitance requirements. In addition, for any specified frequency and K, choice of a low value for R2 will require high values of capacitance and vice versa. The resulting compromise must be made on the basis of the current to be drawn through the filter, and the space and weight limitations. Typical values used in practice for a ripple frequency of 120 Hz would be K = 1, R1 = 75 ohms, R2 = 150 ohms, CI = 8.75 mfd (8 mfd actually used in practice), and C2 = 17.5 mfd (16 to 20 mfd actually used). Rejection exceeds 80 db at design frequency.

Placing a Parallel-T in series with the feedback network of a degenerative amplifier (**Fig. 2**) converts it into a frequency-selective amplifier, by reducing the negative feedback at the Parallel-T's frequency of infinite rejection. Thus the feedback can be arranged to maintain the amplifier's gain at 1 throughout most of the passband, and at the design frequency gain will rise to the no-feedback value.

Adding a minute amount of *positive* feedback to this selective amplifier will turn it into an oscillator. Positive feedback should be kept to a level which will just permit oscillation, while negative feedback (except at Parallel-T design frequency) should be such that gain without positive feedback is unity. The resulting oscillator produces the lowest distortion of its output of any known; the major reason it is not more widely used is that its frequency is determined by *three* component values while the popular Wein-bridge requires variation of only *two* elements.

In either the selective-amplifier or oscillator application, the major considerations are to maintain the impedance of the Parallel-T at a level compatible with that of the feedback network. At frequencies far below that of infinite rejection, the Parallel-T becomes effectively 2R2 in series with the load. At frequencies far above, it becomes essentially R1 in parallel with the load. Thus wide impedance variations with frequency are unavoidable.

However, choosing K equal to 2 will make 2R2 equal to R1, so that if R1 is then chosen to be equal to the load resistance the total impedance will vary from twice that of the load (at low frequencies) to half the load (at high frequencies). This is the minimum impedance variation with frequency which can be obtained from a Parallel-T.

The impedance variations, though, need not be considered a drawback in many applications. A resonant-circuit trap to produce the same effect has similar variations. And the Parallel-T does offer the advantage of much smaller space and weight requirements when dealing with extremely low frequencies, not to mention being less costly to construct in many cases. ■

Starting Off on VHF

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Avon Conn. 06001

With the advancements of current VHF equipment and the continued pursuit in moonbouncing, experimentation, FM'ing etc., VHF operation nowadays is becoming more and more intriguing and certainly offers many rewarding challenges absent in low band territory, where most green eared general's flock for so called "push the button" operation.

Great strides in VHF achievements have been made over the years on every VHF band that exist (when we refer to VHF, this includes 220 mc and 432 etc.). However there still remain vast segments in the VHF frequencies where there is virtually no activity. Some amateurs and organizations have prognosticated that the FCC won't be long or very reluctant in claiming back portions of the current VHF frequencies, generously allocated to us amateurs. This interpreted into another manner means that if we are to retain current VHF frequencies and the privileges that go along with them, we must all help spark more interest in VHF work and if possible, contemplate VHF setups for ourselves, preferrably on 2 or 6 meters and both if possible.

You've probably come across half a dozen or so advertisements highlighting the newest and most recent VHF equipment on the market. And while perhaps not as attractive as a nice low band kilowatt transceiver, you're probably much intrigued as to just what these VHF rigs can do. If you've never been on VHF before, I suggest you start off with a low cost transceiver for say $50.00 or so. Heath company currently offers the "lunch box series" of either a 2 meter transceiver (HW-30) or the 6 meter version (HW-29A). Both units are identical in physical appearance and structure and each sells for $44.95 apiece kit price complete with built in ac power supply and a ceramic microphone. Crystals and a dc power supply are optional. Assembling either unit is simplicity in itself and as a rule, can be completed in a few evenings of consistent work. Transmitter power input is 5 watts and the receiver is of regenerative type. The current ham publications occasionally offer modification plans for these two transceivers in case you'd like to improve upon its performance. I don't think I'm sticking my neck out in saying that these two little rigs are the most widely used low cost VHF transceivers around today.

Coing up the price ladder you'll find several 2 and 6 meter transceivers manufactured by both Lafayette and Allied with an average power input of 20 watts. Receiver is of superhet type and built in VFO is also among the features. Other manufacturers include Clegg Laboratories, Gonset, Johnson in addition to several others. A brief letter requesting their catalog of VHF gear should do the trick and is your first step in becoming familiar with what's on the scene.

What about antennas? Among the numerous VHF antennas are yagis, ground planes, Halos dipoles, collinears, verticals in addition to others. VHF antennas in the majority of cases are much smaller than HF antennas, but the dozens of methods you can use in stacking beams, adding reflectors, experimenting with them, building and designing them, etc., makes VHF antennas a field by itself. Some VHF'ers stack up to five beams one on top of another resulting in a directive gain of over 50 db and sometimes more. Others like to homebrew and construct their own antennas sometimes putting up to 50 elements on one boom! Obviously, VHF antennas offer a unique opportunity to build your own skywires and simultaneously learn more about antenna construction and theory. The complexity to which VHF antennas may grow is-startling. Some of the more advanced and sophisticated antennas used often for moonbouncing, microwave and several other uses are parabolic dishes, helical antennas, screen reflectors and corner reflectors. Some amateurs may stack half a dozen collinear antennas to form an array of enormous gain while others employ perhaps one screen reflector to equal that of the array of collinears. The amount of gain you want and the purpose for its need most often prescribes what kind of VHF antenna installation would be feasible.

Starting off with a commercially built halo antenna will give you adequate local coverage if you have a fairly good location and when hooked up to a low power 2 or 6 meter transceiver, will often provide reliable coverage and makes a dandy little outfit for ragchewing and net coverage. Extending your range using the same low power rig can be accomplished by installing a moderate 2 or 6 meter beam. Seven element 2 meter beams can be had for between $10-$25 depending upon the type and brand. 6 meter beams with three to four elements sell for $15-$30. Installing a yagi beam is no more difficult than installing a good size TV antenna. Attention should be given to the use of a balun however, an item often neglected by many VHF'ers. Use of a rotator is an absolute must if you do intend to use a beam antenna. The many disadvantages of using a beam without a rotator is obvious since the beam will transmit in only one direction and when in net operation with hams in all directions, you'd be lost. Same applies to roundtables with hams in different directions. 50 ohm coax is the feedline used in the vast majority of VHF rigs and its losses through somewhat higher than those of 300 ohm twinlead and open-wire line, are for the time being unimportant.

Range? Normal ground wave transmission on 2 and 6 meters with a power usage of 5-20 watts will as a rule exceed 20 miles and go as far as 45-50 using an omni-directional antenna of appreciable height. Using a beam will extend the range up to 60-70 miles and an occasional 100 mile contact isn't by any means rare. Making use of the ionosphere will of course stretch your signal for a long distance. Tropospheric bending is the most frequently encountered form of DX and 150-200 miles most often prevails in this case, though greater distances have been reached. F2 layer DX occurs at peak years of the 11 year sunspot cycle, and produce ranges nearing 2000 miles. F2 layer DX works well on 50 MHz operation only. Sporadic E layer DX is another frequent ionospheric occurence and normally will produce 400-700 miles or so on 50 MHz and up to 1400 miles on 144 MHz operation. Meteor scatter and moonbounce, among others, are all effective means of obtaining great distances with relatively low power equipment.

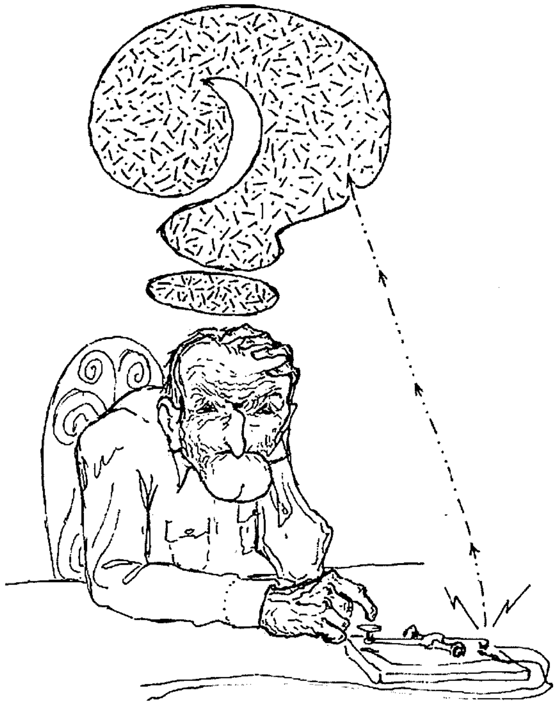
This article merely introduces the basic concept of what to expect on VHF, what's needed to begin and why more activity in this region is desperately needed. 220, 432, 1200 mc and higher have to be further explored and pioneered. For additional information on VHF operation, I strongly suggest you obtain a copy of the ARRL "VHF manual" available for $2.00 directly from League headquarters. If you have any further questions, I'd be glad to hear from you and would like to discuss the matter at length. You might also pen a letter off to 73 Technical Aid Group which is at your service for any assistance you might require. Good luck!

. . . WA1GEK

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

Learning the Radio Code if You're over 30



Do you think aging is an obstacle to learning the radio code? If you are over 30 or 40 or so and you have been thinking of getting a ham ticket, learning the radio code probably looks like the hardest requirement. Actually, it seems to be the hardest requirement for people of *any* age. But if you feel your age imposes a specially tough barrier you are only partly correct. Very probably the difficulty looks much worse to you than it actually is.

The age problem

Any man at age 35 knows he could not win a footrace with himself at age 19. Yet he rarely wishes to trade off those years of experience, either, because he knows how much he has gained. And few 19-year-ods, however aggressive they may feel, will challenge a solid relaxed-appearing middle-aged man in a bar. The younger man perceives a certain stability and potential grim determination the older man can summon up if necessary, and he knows his youth might not be such an asset after all.

Yet our society places an almost frantic value upon youth and is so full of divisions between people the older person undertaking a new project almost certainly must feel at a disadvantage. There are stories of loss of learning ability and of mental capacity, and there are other disadvantages too, against taking up something new that is not related to previous experience or to the work at hand.

For instance, the older man very often has very little spare time. Business and family demands may keep him jumping to the time of a drummer he would rather not hear so much, but he cannot escape the beat. There is rarely an adequate place to study anywhere in the house, and code practice work is often very upsetting to others nearby who are not so interested in ham radio. And starting from scratch, while challenging, can also be a tough uphill operation in which hard work seems to generate disturbingly few results of any kind.

And it is perfectly well established there really is a decline with age of learning ability. This may be too obvious in very elderly people, whose memories tend to show a curious porosity for recent events but excellent recall for things that happened many years previously. Concentration span may be reduced, too, so that an older person cannot accumulate long hours of hard study at the same rate as a younger person. This all certainly sounds ominous, at the very least. Now, is it as bad as it sounds?

Something about learning

If we want to maintain a correct perspective on any problem we ought to do some book work. What are the facts? There is so much information available you can become swamped in it or entirely carried

away. This effect appears in medical schools for example, where as new diseases are introduced and studied there is much concern among anxious students who feel they may have developed these illnesses. Tiny things are magnified by too much attention, but when you discover this effect your perspectives can be rearranged to a truer schedule.

The overall picture of aging effects upon learning ability is surprisingly cloudy. The changes are so small up to age 60 or so (on the average) that researchers are still having considerable difficulty in establishing solid results. Natural differences between people are very large compared to differences due to aging.

Test results indicate a fairly definite peak in learning ability somewhere in the third decade, ages 20–30 years, and a rolloff beyond that decade. But researchers are very careful to indicate they do not know what causes the rolloff, and they suspect a large part of the changes they think they observe are caused by psychological and social changes, rather than losses of inherent learning ability.

For example, studies of training older workers for new jobs have indicated the older worker may simply not be as strongly motivated as the young man. Society expects less of him, he expects less return from society, and has probably lost some, or maybe even all, of his youthful enthusiasm through hard knocks and frustrations. You can find this attitude in some conversation without looking very far at all.

Another cause of reduced effectiveness is the very real need for an older person to do better than a younger one. After all, he has been around longer, hasn't he? Should be able to do better. But the younger man has just completed 12 years of school, say, and perhaps four or five years of college. This is a far tougher experience if he worked at it. At age 17 you may have been viewed as a youngster by your parents and others, but you were also a battle-hardened veteran of many learning emergencies. You were accustomed to everyday hard questions, challenges, tests, book work, writing essays, dodging hard problems. You often succeed, and are not very upset by a prospect of failure. One, two, or three decades later you're so far out of shape for this stress you hardly recall what it's like much less what to do about it. You could panic now, and many older beginners really do.

Research indicates you can achieve practically as well as when you were at your peak, but you've lost the skill. This has been studied closely and one example is that of two professionals aged 35 and 72 years respectively. They did equally well in individual tests but when placed in competition under close observation the older man couldn't take it. He did far poorer work at learning than in previous unforced, non-competitive work.

The anxiety and work-against-pressure and competition effects appear to be the real obstacles in learning the radio code. Tense and worried, you notice the young fellow working like mad in the next seat. Feeling like a relic, candidate for fossil, you probably forget that young as he is he's a veteran, and old as you are you're a beginner. You've been psyched, you're sinking, and your general mood may be as low as panicky despair.

What should you do now?

Learning the code

Well, don't quit. Have a talk with yourself, rearrange your perspectives, and go back at it. You probably were not using the best approach anyway, although this is where your advantage lies. You do have a special strength! The younger man has slightly more learning ability, you have much more experience in life situations. He *can* persist longer than you can but probably you will persist longer than he *will*. He has fewer other things to do but you are more able and inclined to organize your time to best benefit for the job at hand. Now let's look at this code learning problem.

There are three basic parts to learning. They are: Registration, Retention, and Recall. The code signal registers, and it registers best if you are not distracted by other problems or sounds. It sticks best if it registers well and there are not too many other recent things on your mind to compete with it. Finally, the meaning is recalled most easily if the previous two requirements are met, and if the recall process is well lubricated by recent practice.

After a decade or three out of school you tend to forget how slow the learning process really is. Over a period of time you have become accustomed to using familiar information and hardly ever finding new facts, to settle matters most usually worked out in minutes or hours at the most. Now, how long does it take to learn the code?

To reach 13 words per minute, 70 hours or more! At the recommended schedule of a half-hour study per day, that works out to 140 days and you'll need more time yet to attain a higher speed or if your practice schedule is not *daily*. In your second decade this gradual progress was a way of life. You forgot about that, didn't you?

Experience and study suggest the best way to get by with least expenditure of time. Firstly, find out what the books say about learning the code. If you just jump in you are passing up the results of other people's useful experience. A good description appears in the Radio Handbook. Unfortunately, the few paragraphs in the Radio Amateur's Handbook are worse than useless because they imply there is nothing more to it than appears there.

Then set up a study/practice schedule, same time and same place every day. Set yourself at it for a half hour, and for a couple of weeks or so do not ever exceed that time. Stick to your schedule. If later you feel you can profit by longer sessions, try it. But do not work into exhaustion.

If you can possibly find or borrow code tapes or records, use them. They are the very best practice, but many hams have learned the code off the air. You can do it too but it will take longer than a well-prepared schedule of exercises.

Next, stay with it. Do you know what a "plateau" is? This is a familiar experience to educators and to persons whose business is study and learning. A "plateau" is a period in which you are working like mad but there seem to be no results. One of the

purposes of your study schedule is to keep you going from habit if nothing else while you are getting through a plateau experience.

Various persons have different difficulties in code learning, but there is one that probably is common to all. This is learning to "copy behind." In the first stages of learning the code, you are simply discovering which letters have which sounds. You will probably experience plateaus in this part of the work. But then you come to a stage at which you need to copy faster but the concentration on writing interferes with attention required to listen to the next letter.

As you continue working at this you are learning to put part of the work into the back of your mind where it goes on without attention. This is a skill that is hard to learn and probably every amateur you can find will give you another story about how he made it over the hump. At this stage in your progress you should think sometimes about how you drive a car, carry on a conversation while watching the other party. There are many things you already know how to do correctly without paying attention to the details. You have the ability but must train your mind in this new application of it.

I did not find anything while I was working up this article to indicate there are some people who are inherently unable to learn the code. Reading this work was a harder job for your mind than reading a code signal, although the code may be a less familiar way of communicating. If you're a beginner get onto the problem and you will learn the code with considerable effort as we all do, and if you have given it up in despair go back and try again. Plan ahead this time, and good luck!

. . . W2DXH

Oscars . . . Emmies . . . and for the Amateur . . . The Sarah

The next annual SAROC (Sahara Amateur Radio Operators Convention) in Las Vegas will be the scene of the most elaborate and extensive amateur radio "awards" program ever attempted. Sentry Manufacturing Company has just announced the initiation of a continuing annual award presentation program for the ham radio world, to be conducted concurrently by the leading amateur journals.

In a ceremony resembling the Oscar and Emmy affairs of Hollywood, prominent amateur radio operators will be awarded "Sarah" trophies, each of which is inscribed with (1) the winner's name, (2) the category for which the award is presented, and (3) the name of the amateur journal which determined the winner. The name Sarah was chosen because of its similarity to Sahara, the Las Vegas hotel where the presentations will take place, and because it is a natural acronym for Sentry Amateur Radio Award of Honor.

73 will distribute awards for DX, VHF, public service, best technical article of the year, best nontechnical article of the year, and best published solid-state design of the year. 73 will also present one additional Sarah to the individual considered by the staff to be the Outstanding Amateur of the year.

All but the last mentioned category will be determined by 73 readers on the basis of mailed in nominations which will be accepted until 10 October. On this date, three individuals will be selected from the nominations for each category as finalists; their names will be published in the December issue of 73. The names of these candidates will be forwarded in early December to the Sarah Committee, who will objectively evaluate the candidates and select the winner in each category. The Committee's decisions will be final.

Once the Sarah Committee has made its decisions, the winners' names will be forwarded to Mr. Ray Meyers (W6MLZ), a prominent west coast amateur, ham radio columinst for the Los Angeles Herald-Examiner, and radio commentator. Mr. Meyers, as emcee for the SAROC breakfast banquet, will make the actual award presentations.

No photo of the trophy is available yet, because the original design work is still under way. It will have the general character and size of a conventional Oscar award, however, consisting of a male figurine about 15 inches in height. The figure will bear a lightning bolt representing electromagnetic radiation and will be supported on a small pedestal of marble encircled by a metal band for the inscriptions.

Selecting Nominees

Nominations are now open for the six listed categories. Use as much paper as necessary and list the names of your candidates in any format you choose. For each category, try to list the name, call, and address of the individual you have named. (This is not mandatory, but it would be immensely helpful when it comes time to notify the winners.) In as few words as possible, tell your reasons for selecting your candidate. You are entitled to only one nomination per category per journal, so be sure to sign your name and list your own call letters. Here are the particulars on the six 73 Magazine categories:

Best Technical Article of the Year.—Look through the pages of back issues of 73 to September of last year, and pick out the one technical article that seems outstanding to you for some reason. Perhaps it was a useful circuit that you used; maybe it was an informative piece that did a good job of filling in fuzzy spots in your theoretical understanding of a subject. What-

ever your reason, write it down. Tell the name of the article, the author, and give your reason for naming it the best technical article of the year.

Best Nontechnical Article of the Year.—73 often carries outstanding nontechnical articles of interest to radio amateurs. As you look through those back copies, select a particularly important nontechnical article that you believe warrants perpetuation in the annals of ham radio. This entry might be any article from the pages of 73 that you found particularly helpful for some reason. All you have to do is give the name of the article and the author, and cite the reason why you feel the article is outstanding.

Best Published Solid-State Design of the Year.—This should be no problem at all. 73's pages are rich with solid-state projects and articles from its knowledgeable readers. Which of these did *you* build? Maybe a published integrated-circuit article helped you in a miniaturization project. Or maybe there's a design you've been saving to try later. List the deisgn you think is best and give your own reasons. Remember, you are the one who determines where these coveted awards will go.

73 Public Service Award—Here's an area where back copies probably won't help. Do you know an amateur whom you feel has contributed something "extra" to his community on behalf of amateur radio. Maybe you know of someone who went out of his way to do a service for a fellow human, such as using his radio station to pass traffic in an emergency. Or perhaps you know of someone who has performed some service for the benefit of the public that is undramatic in nature but worthy of commendation. He'll never be commended unless the anateur radio world knows of his actions. Give his name, call, address, and state his praiseworthy act.

VHF Award.—What individual do you feel most deserves a citation of merit for performance in the field of VHF? A two-meter moon-bouncer? A six-meter DX'er? A 432 experimenter? It's up to you. Give his name and call, and state why you feel he is particularly worthy of being awarded the VHF Sarah.

DX.—What amateur radio operator do you feel has contributed most during the year to the field of amateur DXing? There are quite a few to choose from. Who went out of his way to give fellow amateurs a chance to work rare countries? How about a DXer who stayed selflessly for hours at the mike so that more amateurs could add a particular country to their lists? What do *you* think? Some amateur will be awarded a Sarah for DX, and it's your job to determine that individual.

The most important thing to remember is to get your nominations in before October 10. As a matter of fact, why not do it now—before you forget? Use any kind of paper. Write it longhand or typewrite it—it makes no difference. All nominations are welcomed. At the top of your sheets, place your name, call, and address. Then list the categories, your nominations, and your reasons as indicated above. Then mail your entry to:

73—*Sarah Nominations*
One Radio Ranch
San Dimas, California 91773

1296 Megacycles-1968

Bill Ashby K2TKN
Box 97, Sunet Lake
Pluchemin, New Jersey

Without doubt, this UHF band of Amateur frequencies has the most promise and with a few outstanding exceptions, provided the least results. Consider the tremendous efforts put forth by Sam Harris and his whole group at W1BU, Hans and the group at HB9RG, the Eimac club on the West Coast, and Tommy, KH6UK, in order to get the first Moon-bounce contacts on 1296. These must be considered as successful experiments that provided all of us with some valuable numbers but lead nowhere at that time, for these groups found it necessary to use equipment unobtainable to even the very serious UHF Amateur. Like mountain-climbing, after getting up there and back, you are not really sure it was worth the effort and certainly not worth repeating—what do you do for an encore! The other side of the coin is the poor soul who reads a glowing report in an old issue of one of the magazines, talks his buddy into this deal, scrounges up a couple of APX-6's, and they spend the next few weeks getting these bombs working, just to find they could have done better with a TWOER and a clip-lead antenna.' This can be described as an old experiment, often repeated and not leading anywhere. All in all, a pretty poor piece of *rf* spectrum considering the problems of Antenna, impossible feedline losses, *rf* output and drive headaches, and a 15 db noise-figure with a handbook converter. How many times have you heard, "Boy, 1296 would be the band if you could work Moon-bounce, using 2C39s and a back-yard antenna." *Friend, that is precisely what G3LTF and WB6IOM used to get signals from California to England in June.* If this seems impossible considering the problems mentioned, you are forgetting the availability to all Amateurs of Varactors, Transistors, 3 db couplers, and the experience of those hardy pioneers on 1296.

"3 db Coupler—Whats that?" That is a simple flashing-copper box or piece of strip-line that allows you to use *one* 2C39 amplifier to drive *two* 2C39 amplifiers to drive *four* 2C39 amplifiers, etc. etc.

This same little box provides right-hand circular polarization transmitting and left-hand receiving without switching.

As the memory expert once said "I don't have anything that every four-year old doesn't, but I have spent 30 years developing it" aptly describes the work of the two Peters, G3LTF and WB6IOM. Although each is an extremely competent, state-of-the-art electronics engineer, they have chosen to expend their energies in the direction that many of us more-or-less fortunate Amateurs understand and can participate in.

The best example possible to describe the type of development work Amateurs do best can be summed up in the unit amplifiers being used. Starting with the 2C39 triplers described years ago by W1WID, add the cavity development by WB6IMO (QST Jan 68), Vapor-phase cooling by W2CLL, and a year of hard work on final design of Cliff, W2CCY, and any Amateur anywhere in the world can build a 1296 transmitter of any reasonable power deemed necessary. Of course, the availability of Ceramic 2C39's and 3 db couplers helps, but would be useless with out the efforts of the above Amateurs.

Keep in mind that these signals on 1296 are the weakest signals ever used for communications of any kind, so nothing can be skimped in the receiver. Amateurs have been building par-amps successfully for ten years now and the ready availability of low-noise (5 db) transistor for second stages and mixers (QST Nov. 67) has eased the receiver problem. See info by Al K2UHY on *rf* amplifiers. Replace the collector circuit shown with a two-meter tuned circuit and link. Reduce the bias for 100 microamps of collector current, then inject enough 1152 MHz via a link near the base circuit to drive the collector current back up to one mA. and you have a low-noise 1296 mixer. We have finally seen the last of crystal sets, even on 1296!

Antennas, feed-line and tracking problems are still just as big a problem as ever, but Peter WB6IOM has shown us all that if you get the transmitter and receiver straightened out, a 10 ft dish on a simple back yard mount with a coffee can feed will cut the

buck—it doesn't make it easy, just possible. After finding his echoes with the par-amp, Peter can still hear them with the 5 db second stage, so he sure has the antenna situation well in hand.

During the past year, steady progress has been made here on the east coast by Cliff W2CCY who has managed to interest quite a group into getting on 1296 for nightly local contacts. He has shown that 18 db of antenna and 50 watts of clean signal will do a real job out to 70 or 80 miles without openings of any kind. Transistor front ends have made a significant improvement in this type of work in the past year.

1296—1968 It should be recorded somewhere that this was the year that Dick W2IMU and the group at W2NFA not only generated a successful series of 1296 tests out of Crawford Hill that resulted in contacts with Europe and California, but of far more long term import, lead to the back-yard to back-yard signals of WB6IOM to G3LTF with much more to follow.

. . . K2TKN

VHF Awards

As many of the VHF hams are interested in getting some sort of wall paper to show off to their visitors, I will try to get a few listed just in case you might want to paper the wall and not pay a lot either. Many of the numerous certificates I have were absolutely free of any cost other than the stamp and the envelope. Of course, I think my proudest one is the DXDC #404 from 73 with the 6 meter endorsement. I have the letter from Wayne telling that it was the first for 6. I know many others are qualified but there again, some do not go in for even QSL's.

I have been quite active on the air with both this call and also my 2nd station K8BDT but never had so much fun till I went to SSB over a year ago. I helped form the Florida VHF Sidebanders, of which I am president. Any one working 10 full members of the gang; send the info to me and receive a very nice certificate free and postpaid.

The Golden Triangle Coffee Club has 2 nice ones; one for working the 5 charter members and the other for checking into their morning get together on 50.5 between 6 and 7 AM. Send 3–6 cent stamps to WA4VVW along with the info from log. You also must send QSL's to members worked.

The Floridora Y L's have a very nice one for working 10 of the gals, any mode or band, the info with 35¢ to K4RNS. Endorsements for each extra 10 gals are available from Marg.

The Florida Chapter of the National Awards Hunters Club has a real nice award (along with 4 gold seals) for working 150 of members of NAHC. Many of them count as 2 due to being charter members of their chapter, so get out the old shoe box and start looking for them. Then send list, and 3–6¢ stamps to Al Man—WB4CQU.

The Bayou City VHF club of Houston, Texas also has a real nice one for working 7 member stations and sending the log data to WA5DUJ. A few stamps would be appreciated.

The 6-meter club of Dallas (Texas) has a nice one on parchment for working member stations. Send to Louise—K5ZAM with SASE for correct number to qualify.

The Greater Pittsburgh VHF Society has a nice gold one for issue. Send SASE to W3BWU for more details, other than the fact it's for free.

WBCQU is also custodian for the Michigan Screwballs. Send a few stamps along with the "Screwballs" worked and even get a pin & your certificate.

The Wheat Straw Radio Club in Calumet, Oklahoma has a nice one for working 6 member stations and sending a stamp or so to K5GBN.

Another nice one and free to the XYL, can be had for sending a note to Mabel % W4IYT (editor of Fla. Skip) telling how much she does putting up with you as far as ham radio is concerned.

. . . K4LLF

The VK3ATN Moonbounce Rhombic

Wayne Green W2NSD/1

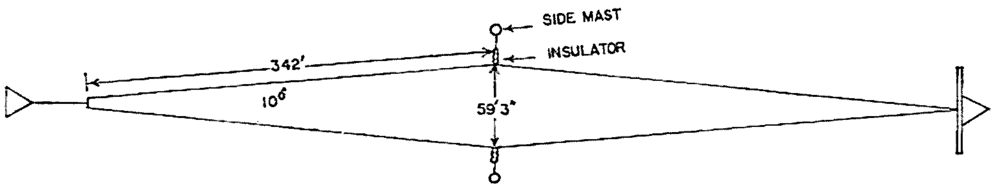


Fig. 1. The Moonbounce Rhombic doesn't require very high towers, the top of it being only 35' in the air. The ends of the antenna are tied to the two end towers and the slack in the wires is taken up by counter weights on pulleys on the side masts. A track on the tower in the forward direction permits the whole rhombic to be swung a few degrees one side or the other to permit aiming it at the moon and thus giving you four or fire days a month for bouncing instead of the one or two you would get if it were fixed. The side pulleys permit easy moving of the positions of the side wires to keep the antenna in shape. Ray tried apex angles between 8° and 12° and found that 10° seemed to be optimum.

In January 1966, after being convinced by W1FZJ/KP4 that a long, long rhombic would have the gain necessary for moonbounce on two meters, even with the 150 watt power limit of Australia, Ray Naughton, VK3ATN started researching the published data on these antennas. It was sparse indeed. He worte to some "authorities" to find out what he might be able to expect from, say, a 50 wavelength long rhombic.

It soon became apparent that he would have to just go ahead and build one and find out for himself what actual in-practice gain he would get, what lobes would develop, and even more important, what the actual direction of radiation would be. This was, understandably, critical since he intended to point the gigantic antenna at a spot in the sky where the moon would pass on about two days a month. Even a few degrees error and no moon.

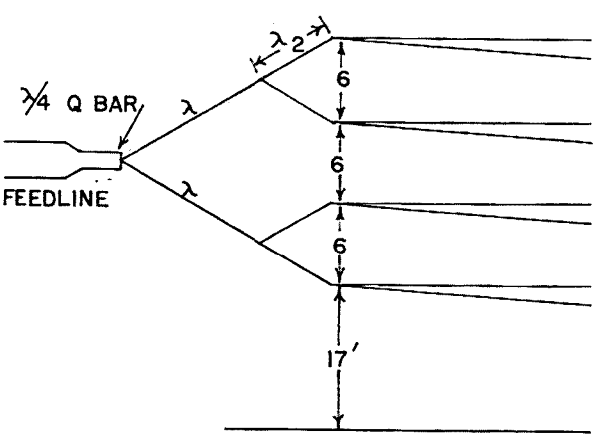


Fig. 2. The bottom rhombic is 17' off the ground. The other three are one wavelength each above that, 6'. They are fed by half wave sections which are in turn connected by two full sections of feedline. The match is made with a quarter wave Q-bar. The half wave, full wave and feedlines are all made with #12 AWG hard drawn copper wire spaced ½".

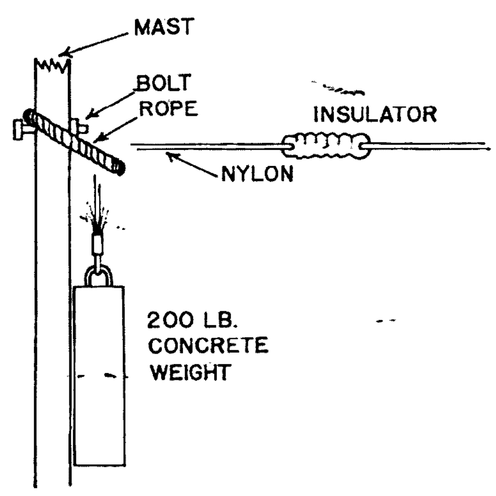


Fig. 3. The 200# concrete weights hold the wires of the rhombics so that there is only about 2' sag in the 342' stretches of wire. You'll need four of the weights for each side, one for each rhombic. Arrange to have them hang down close enough to the ground so you can reach them without a ladder as you have to adjust them now and then, particularly when you want to swing the antenna a few degrees one way or the other.

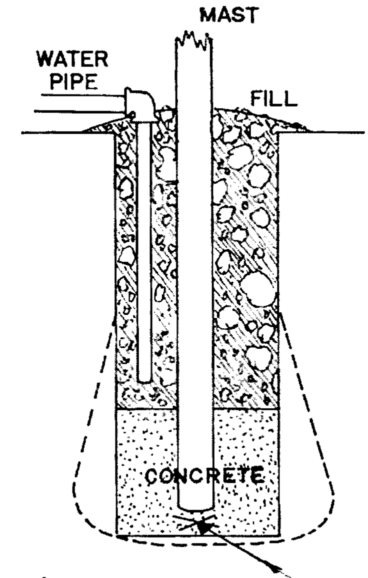


Fig. 4. Ray has towers and masts all over the place and has some good words for planting these things. If you want to plant a tower or mast so it will stay planted through anything dig your hole down as diagrammed. Put a couple of pieces on the bottom of the tower to keep it from pulling up vertically. Put a small dynamite charge in the bottom of the hole. Fill up the hole a little less than half way with concrete. Then put a water pipe down into the hole, almost down to the concrete layer. The end of the pipe should be perforated. Fill the hole with dirt and stones to a mound above the top. Set off the charge. This will expand the bottom of the hole and fill it with the wet concrete. Then run water into the pipe until it runs out the top. Pull out the pipe and when it all dries out you will have a tower or mast that will confound your great-great grandchildren.

Rhombic theory was fairly well established, but Ray wanted to stack them and little had been done on this. Collins had used stacked rhombics during some of their tests during the 50's on 49 MHz, but their published data was of little help.

During February 1966 Ray erected a 50 wavelengths long two-stacked rhombic. He missed the February moon pass, but was all set for the March pass and, sure enough, back came his echoes. They were weak so he got to work and added two more rhombics to the stack. The result was definitely readable and at times strong. By June he was getting good readable signals through from K6MYC on scheds, but Mike was having troubles in receiving and not yet able to hear his own echoes, much less Ray's.

The first two way for Ray turned out to be with K2MWA. The boys in New Jersey got a chance to use the big dish there during the December 1966 moon pass and K6MYC, who had just installed a receiving filter and was finally set to work Ray, had to sit there, biting his fingernails, hearing both K2MWA and VK3ATN, but missing out on the first U.S./Australia two meter moonbounce contact. This was in November 1966. In December it was Mike's turn and he made it through to Ray.

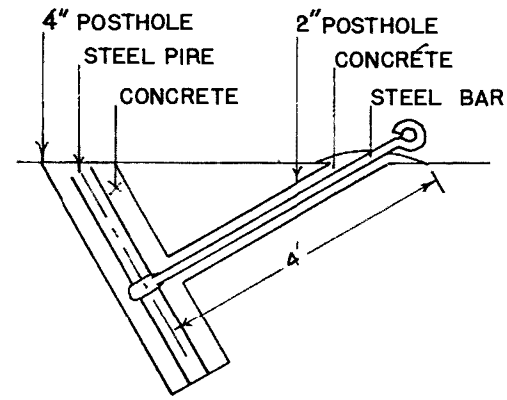


Fig. 5. Most of us just screw our guywire deadmen into the ground and let it go at that. Not Ray. He makes a permanent job of it per the diagram. Use a 4" posthole digger and cut into the earth at about a 45° angle away from the guy wire direction. This hole should be about 6' deep. Then with a 2" posthole digger run a hole in from 45° in the other direction so it comes out in the 4" hole. Put your 4' long guy shackle into the 2" hole. The ring on one end should just stick above the ground and be verticle with the ground. The other end of the shackle has a ring at 90° from the top one and a steel pipe should be passed through this ring and driven into the ground until it is below the ground level on top. Do not use galvanized pipe as this will rust. Fill in both holes with concrete. Let the concrete come up around the loop on the end of the shackle to half cover it for maximum strength. This is a little more work, but it is not likely to come up in a wind.

The bounce club had regular get togethers on 15 meters to coordinate their work and schedules. They decided on a code for bounce contacts to save time. "1" meant they were hearing occasional signals, but that they were not identifiable. "2" indicated identifiable letters. "3" meant complete call sign and report received during two minute call period. "4" indicated almost 100% copy. "5" 100%. After using this system for a while they found that the dots of the numbers tended to get lost in the fading. Next they

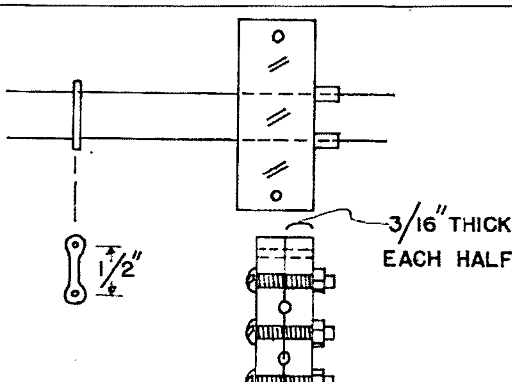


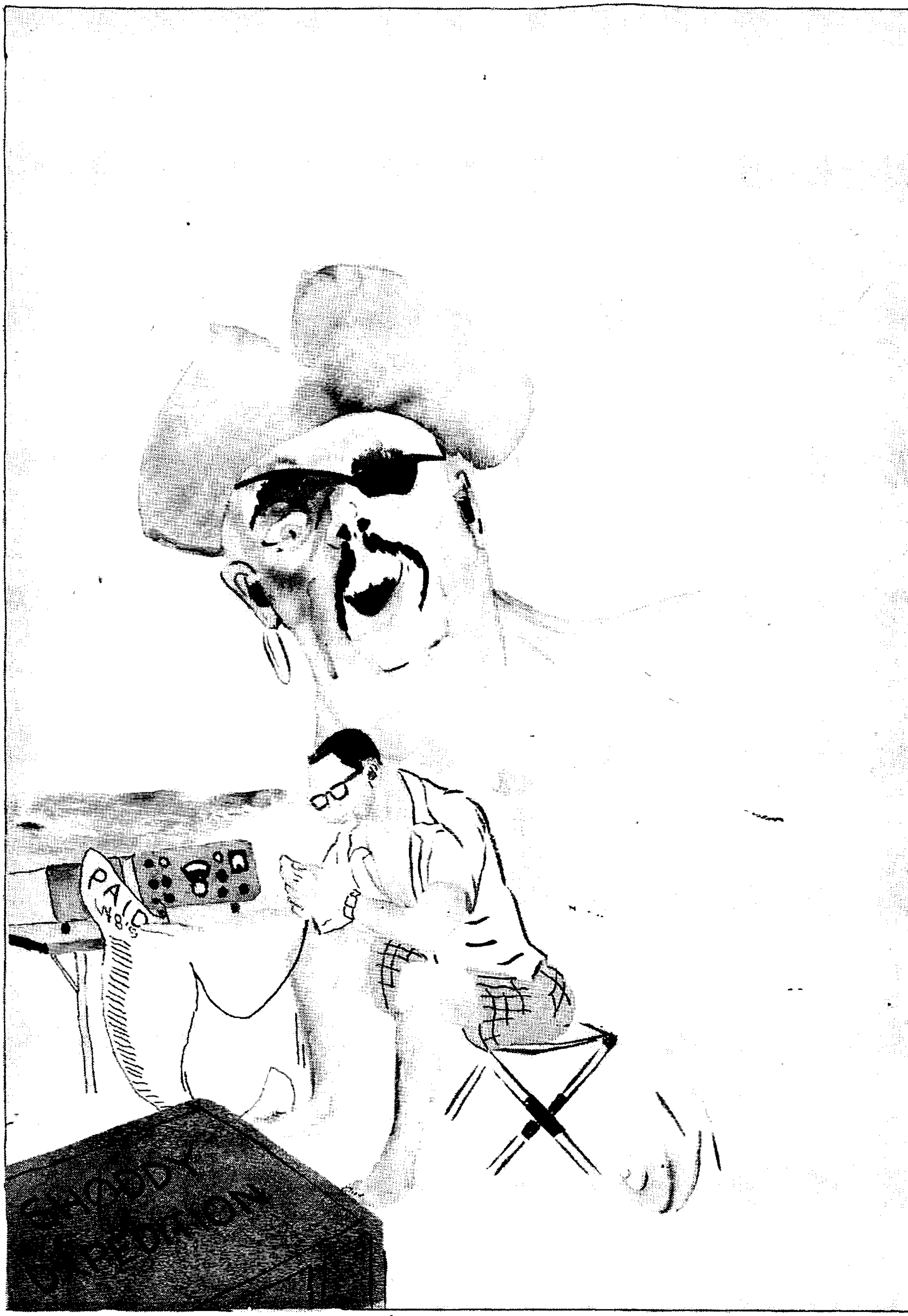
Fig. 6. Ray uses these little half inch spacers for his feedline. They are spaced out every 8' along the line to keep any discontinuity to a minimum. On curves he puts them above every 6". He keeps about 200 pounds tension on his feedlines to keep them in shape, taking up the strain with blocks per the diagram. These polystyrene blocks are used to hold the half and full wave sections, the Q-bar and the feedline taut. The loss of the system is kept very low this way. The half inch spacers are a commercially made item, the blocks are home made.

tried sending "T"s for 1, "A"s for 2, "E"s for 3, "I"s for 4, etc. Still not so good . . . losing those dots. The present system is to use a series of "T"s for 1, "M"s for 2, "O"s for 3, "MT"s for 4, and plain SSB for 5.

The frequency used is around 144.09 MHz. The stability must be good, staying within a few cycles. You have enough problems on moonbounce without having to tune around the band chasing signals.

Ray experimented with various aperture angles for the ends of the rhombic. He tried from 8° to 12° and settled on 10° as being the optimum. It is rough making empirical tests like this for those two days a month go by rapidly and take a long time to come again. On April 24th he got back about 8 minutes of echoes. Nothing on the 25th, the 26th, 27th or 28th, then 12 minutes of echoes on the 29th! More changes and then in May nothing on the 20th, 21st, 22nd, 23rd, and 24th. At last, on the 25th some echoes! And nothing more for the month. It is slow frustrating work this way.

Would tilting the rhombic elevate the lobe? No way to know until you try it and see what happens. The answer, to save you a few months of finding out for yourself, is no. . . . W2NSD/1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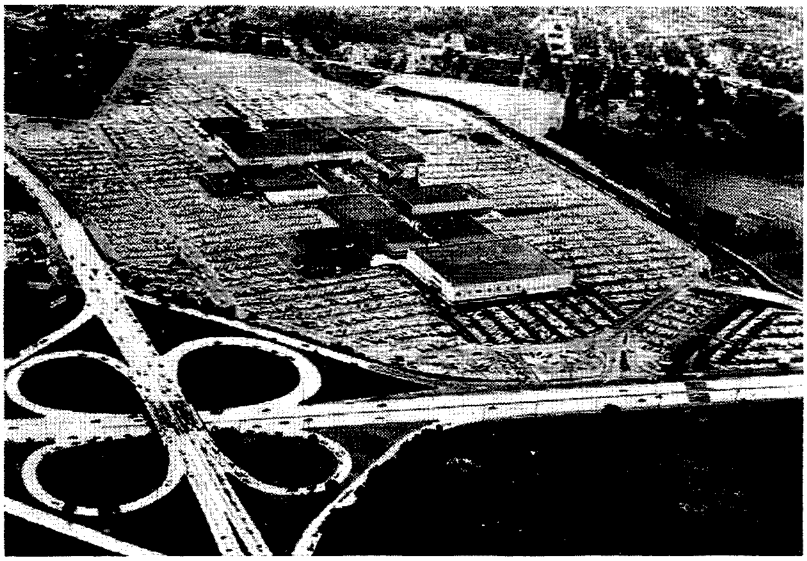
K2US: 1968 Ham Radio Expo



Mel Snyder WB2DLW/K3AFW
Box 15
River Edge, N.J.

In an era when citizens band and commercial gear have supposedly stolen much of amateur radio's glamor, 15 ham clubs from northern New Jersey believed that all the hobby needed to recapture the public awe was a little overdue exposure. They got their chance to prove this theory at the Garden State Amateur Radio Exposition.

Like most great ventures, this "Ham Radio Expo" started with a lucky break—Steve Flehinger, assistant advertising and public relations manager of the Garden State Plaza, Paramus, N.J., saw a story about Vietnam phone patches in a local newspaper. The story suggested to him the possibility of a major public display at the Plaza, world's biggest shopping center. He contacted first the FCC and then the Newington gang for advice.

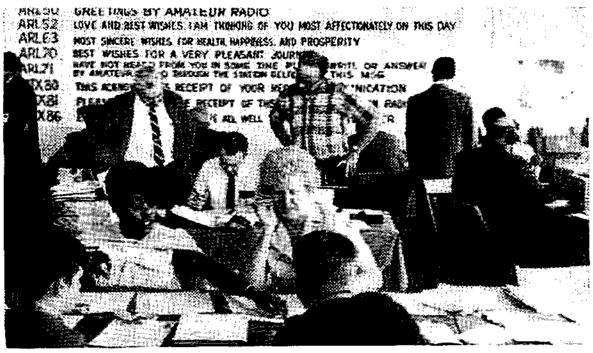
Several months later, north Jersey's hard-working SCM Louis Amoroso, W2LQP, finally got wind of Steve's inquiry, and put out a call to area clubs for an organization meeting. Twelve clubs, associations and emergency groups, including such angust names as the North Jersey DX Association, Quarter Century Wireless Association and the East Coast VHF Society, sent members. Other clubs present or soon to join included the Bergen Amateur Radio Association; Englewood Amateur Radio Association; Knight Raiders VHF Club; Land Rovers Amateur Radio Club; NASTAR; New England .FM Repeater Association; North Jersey Radio Club; Stevens Institute of Technology Radio Club; Tri-County Radio Club; Watchung Hills H.S. Radio Club; Oakland 550 Club; Army, Navy and Air Force MARS.

Harry Dannals, ARRL Hudson Division director, attended the meeting and was stunned by the response; the League had withheld official endorsement of the Expo, fearing it might "conflict with the division convention in Tarrytown later in the year." Dannals noted that no division convention ever began so enthusiastically.

As committees formed and the work began, the club representatives made clear the reason for this enthusiasm—the Garden State Amateur Radio Expo was to be no ordinary hamfest, where hams merely talk to hams. "Expo" was to be a unique opportunity to open lines of communication to area non-ham publics, ranging from prospective amateurs to influential community leaders who often decide anti-tower ordinances and what to do about serious TVI cases. Given the chance to change some of the "bad ham" image, north Jersey amateurs attacked the opportunity like a smoking Field Day rig.

For Steve Flehinger and his supervisor, George Chirogene, the planning was awesome.

"This hobby dissolved into a tangle of ominous words and phrases like "high volt-



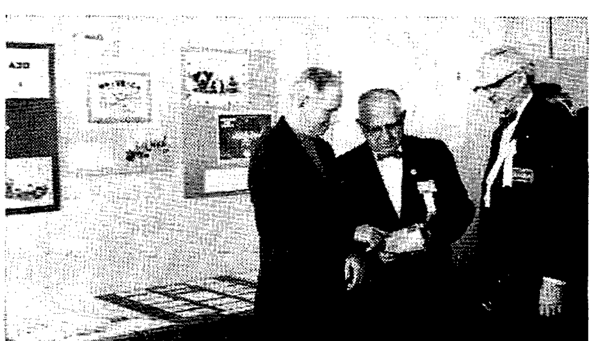
Two Red Cross volunteers help young visitors fill out message forms at traffic setup at Expo.

age," "250-foot coax feedlines" and "just how many amps is this place wired for?" Steve recalls.

"This place" was an empty store in the giant Plaza—7000 square feet of highly prized space, with big plate-glass windows on three sides. And the Expo dates couldn't be more attractive—May 2 through May 4, anniversary sale days at the Plaza, when perhaps 75,000 of the area's bargain-happy shoppers would flock to the center.

Despite possible incidence of Murphy's Law, Expo rolled along from its January beginning. Qantas obligingly flew in Ray Naughton, VK3ATN, of "Moonbounce" fame. Ray captured the interest of hams attending the VHF Conference, which also starred Ralph Thomas, KH6UK; Hans Lauber, HB9RB, who contacted Raf's friends at Crawford Hill Amateur Radio Club via 1296 mc moonbounce less than a month earlier; Ray Conkel, W6DNG, and many others. The public was charmed by Ray's great Aussie accent and his fine color slides of "down under."

With a few days to go, the FCC approved K2US for use at the Expo. And NASA sent



Three well-known DX'ers: Ed Hopper, W2GT; "Musty" Mustermann, W2TP; and Vic "the Digger" WA2DIG discuss the ragged shape this recent pack of DX QSLs arrived in (note: all were salvaged and forwarded!)

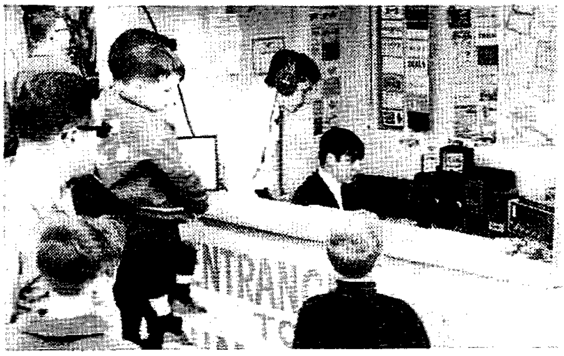
a "Surveyor" satellite display, and prepared for two theater shows on outer space for Saturday crowds.

Bergen Amateur Radio Association presented "Gateway to Amateur Radio," an exhibit showing how to obtain an amateur license. The thousands of Expo visitors watched BARA member Paul Irvine, WA2ANI, and his dad, John, K2GXX, assemble a Heathkit receiver at the booth. Hundreds of youngsters received "Certificates of Communication" marking their first contact via amateur radio, over a 2-meter station in the display. Another section of the BARA

A moving moment at Expo: blind non-amateur at left is shown how to tune receiver by unidentified Mount Carmel Guild ham who is also blind.

display handled visitor questions about TVI, and how it can be cured. A key part of this section was an operating portable TV set with only a rabbit-ear antenna, operating only a few feet from the SR-2000 station loaned by Hallicrafters for K2US contacts—the screen never once betrayed a hint of interference. Hallicrafters donated 12 of its amateur license course kits for a drawing at the BARA display, and hundreds of youngsters flocked in hopes of winning the combos of code record, ARRL manuals and CPO.

East Coast VHF Society members demonstrated the latest in VHF gear and communications techniques. An amateur TV two-way station set up by Alan Katz, K2UYH, drew large crowds, as did a 16-foot-long OSCAR tracking station exhibit set up by NASTAR's Nick Marshall, W6OLO/2. Nick, who was technical director of OSCARs I and II, used big display boards to show visitors the contents and functions of all OSCARs to date, and exhibited a model of OSCAR I in the booth. Nick also displayed plans for Project Moonray, and demonstrated a sub-laser communications system over which visitors could speak. The modulated laser beam was de-



CW aficionados Steve Petrucelli, WB2WPX, and Al Bianci, WA2BCN, dazzle Expo visitors with dits and dahs at the outdoor information booth.

tected and used to modulate a 432 MHz transmitter, similar to the way Project Moonray may operate.

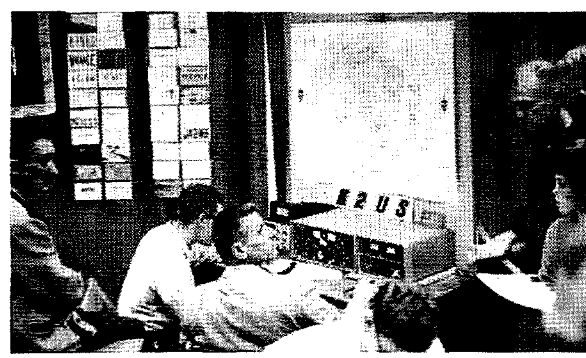
Land Rovers Amateur Radio Club showed the public the wide range of RTTY activities possible, from traffic handling to general QSO and "picture" transmission. Prepared tapes on Expo fed a network of teletype printers around the exhibit hall, telling visitors about Expo activities and amateur radio. The New England FM Repeater Association, organizers of an FM Conference held in conjunction with Expo, presented an impressive display on the equipment and communications networks possible with this mode.

Englewood Amateur Radio Association and Tri-County Radio Club combined to present "This is Field Day," an exhibition of a tent-based station and panels of photos and newspaper clippings of past FD activities. An exhibit showing the performance and preparedness of the Amateur Radio Emergency Corps was sponsored by the Knight Raiders VHF Club.

Contrary to his Aussie comrades' jest, VK3ATN is not the longeared type at center! He's at right, displaying the friendly little kangaroo the Garden State Plaza brought to welcome Ray to Expo. Dick Turrin, of the Crawford Hill (NJ) Radio Club group that first QSO'd Ray via 144 moonbounce, joins in the fun.

Traffic-handling at Expo was directed by Doug Rue, WA2ASM, Tri-County Radio Club, and Knight Raiders president Jack Wilk, K2KDQ, net control of the Passaic Valley Traffic & Emergency Net. Their club members manned VHF and low-band rigs operating AM, SSB and RTTY in routing traffic to the National Traffic System and MARS on 75, 6 and 2 meters. Outside the Expo hall, in their mobile trailer crammed with gear that left public and hams a little awed, personnel from First Army MARS alternated between handling Vietnam traffic to Hawaii and showing visitors the equipment.

North Jersey DX Association was prominent with a display prepared by Herman ("Musty") Mustermann, W2TP. The display showed the wide range of awards and trophies for which amateurs compete using

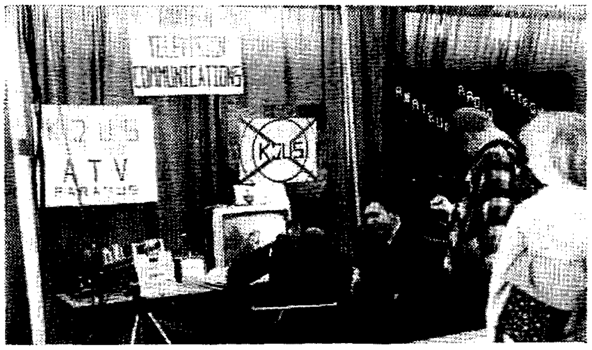


In a typical moment at K2US, BARA vice president Marv Tischler, WB2TEA, takes a break from contacting to explain station to visitors.

QSL cards, as well as the methods the association uses to handle their QSL bureau responsibilities for the second call area—22,000 cards per month, on the average!

Proof of the hobby's unique rewards for the handicapped were displayed by Alex Alexi, WA2AJE, and other hams from the Mount Carmel Guild, Newark. In a display assembled by Stevens Institute Amateur Radio Club, Alex and others showed blind and sighted non-ham visitors how one tunes a rig when deprived of vision.

Ed Raser, W2ZI, proprietor of one of the nation's top antique radio museums, displayed and demonstrated amateur transmitting and receiving equipment from the early days of the hobby. Ed, who splits his time between SCM duties for southern New Jersey and representing the Delaware Valley Chapter of QCWA, highlighted the display with a crashing half-KW rotary spark trans-



K2US-TV, set up by Alan Katz, K2UYH, gives visitors a look at a homebrew ATV station.

mitter, and a commercial 10 KW hand key as big as a billy-club.

Watchung Hills High School Radio Club prepared a display on radio astronomy for the Expo. The Watchung Hills students showed equipment and antennas they have built for studying signals from deep space and solar and moon-reflected noise. Photo displays illustrated how amateur radio operators began this field in the mid-30's. The students also ran a rear-projection movie on the history of radio that drew 15-40 viewers at every continuous showing during the three-day exhibition.

The recently-formed Oakland 550 Club showed equipment built for hidden transmitter hunting—transceivers, portable loops, etc. An impressive scrapbook of photos and newspaper clippings confirmed the club's expertise with their gear.

Out on the mall area of the Plaza, WB2DLW and other BARA members manned a 40 CW station that attracted hundreds of shoppers to the Expo information booth, and then into the main exhibit hall. Posters explained the reasons for CW, code requirements for various license classes, and the QRP International Amateur Radio Club rules under which the station operated.

And there were many others— *73, Ham Radio,* International Mission Radio Association, and even a small ARRL booth that contributed to the overall view of amateur radio seen by the crowds. Local newspapers carried Expo news on Monday, Tuesday, Wednesday and Friday of the action-packed week, helping to swell the crowds.

To those who called K2US and were not answered, we offer only the apology of heavy local QRN and our primary responsibility of

Jim Joyce, WB2MEE, holds ticket-stub box for IMRA's Brother Carman in drawing for Hallicrafters code sets at BARA booth.

telling the public about ham radio; to those who were answered, we ask that you QSL via the Bergen Amateur Radio Association, Box 15, River Edge, N.J.; BARA will route cards to those stations you QSO'd at Expo.

Now that the Expo has ended, planning for the next Expo seems imminent. The event did a great deal for the image of amateur radio in north Jersey, and should be a model for others elsewhere.

. . . WB2DLW/K3AFW

First Army MARS operators show visitors inside of van packed with military equipment. MARS maintained link to Hawaii throughout Expo to handle Vietnam-bound traffic.

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6 Meter Exciter

Kenneth W. Robbins W1KNI
Sperry Rand Research Center
Sudbury, Mass. 01776

During 1965 "73" magazine published a series of articles by Bill Hoisington K1CLL describing heterodyne transmitters for 6 meters.[1] They are fine rigs, the writer having verified performance by breadboard models. Cold start frequency drift averaged about 1 kHz and this only during a short warm-up period, thereafter holding steady within 100 Hz or so. During the summer of 1966 a modified version of his Slippery Six[2] was constructed using a 3A5-lR5-lL4 tube line-up with solid state regulated power supply. After a few minutes, frequency drift would level off to about 50 Hz per hour even with line voltage excursions of 20 volts. Spurious output signals were 36 db below a 75 mw carrier which drove a 5763/829B transmitter.

Like some vacuum tube receivers, oscillator power may be left on to eliminate warm-up drift. In early 1967 an "always-on" experimental VFO was built using two 2N706 bipolar transistors in an oscillator/buffer configuration on 14MHz. Ambient temperature variations were smoothed by a ¾ inch soft pine enclosure lined with aluminum foil.

After stabilizing for 24 hours it was operated as a carrier-reinsertion signal on 20 meter SSB stations with receiver in its AM mode. No drift or instabilities were detected. Assuming the SSB station is drift-free, this test requires 50 Hz or less frequency change to keep a voice sounding natural. For home stations use, continuously powering frequency generating circuits is OK but is not too practical for portable or mobile use.

Experience with bipolar transistors has shown they are not easy to "tame" for VFO use[3] but most certainly the new FET's are a natural. One of the first to appear was W2YM's unit with eye-bugging performance figures.[4] Recently W1DTY described his version using JFET's.[5] These new unipolar devices when used in a modified Solid State Slippery Six[6] enable the construction of a hybrid 1 watt output 6 meter exciter having excellent frequency stability, small warm-up drift, low spurious output and 12 volt dc operation (dc/dc converter for tube b+). How this may be done and resolving of various problems that arose is recounted in the following paragraphs.

Little difficulty with the VHF crystal oscillator was expected so its design came first. As is well known, power dissipation in these crystals *must* be kept small to minimize drift due to heating and accelerated aging. For CR23/U and similar units, maximum power specification is 2 mw. How to stay within this limit without some kind of automatic leveling feed-back? Since class C oscillators are amplitude-limiting why not reduce B+ to a low value and thus power in the entire circuit. Many transistor spec sheet curves show good gains with a volt or less and Ft extending into UHF frequencies. A silicon transistor made for TV tuner local oscillator use is the GE 2N3662 having an Ft of 1.2 gHz and priced at 75 cents. It appeared to be a likely candidate so breadboarding commenced with B+ supplied by a single flashlight cell. Of various circuits tried, we liked K1CLL's the best since it does not require "tuning out" crystal capacity and impedance levels around the quartz loop are low and easily optimized. Overtone crystals between 45/46 MHz were tried and CB transmit crystals running on their fifth overtone worked just as well; this rig uses a channel 23-T unit marked. 27.255 whose 5th O.T. is about 45.425 MHz.

Low B+ seems to be one easily applied technique in getting crystal power down because warm-up time averaged 5 minutes with a drift of 15 Hz then holding steady within 10 Hz, when checked on a frequency counter. Temperature has a large effect on frequency; warming the metal can with finger heat will produce a few hundred Hz change. It was decided to power the VFO continuously during operation, switching the crystal oscillator off during receive.

Using a resistor as a coupling element, buffer base drive was adjusted for best mixer performance with minimum 45 MHz signal. Other things being equal, frequency insensitive resistance coupling reduces pulling as compared to reactive devices.

VFO circuitry evolved into a configuration using W2YM's oscillator with a source fol-

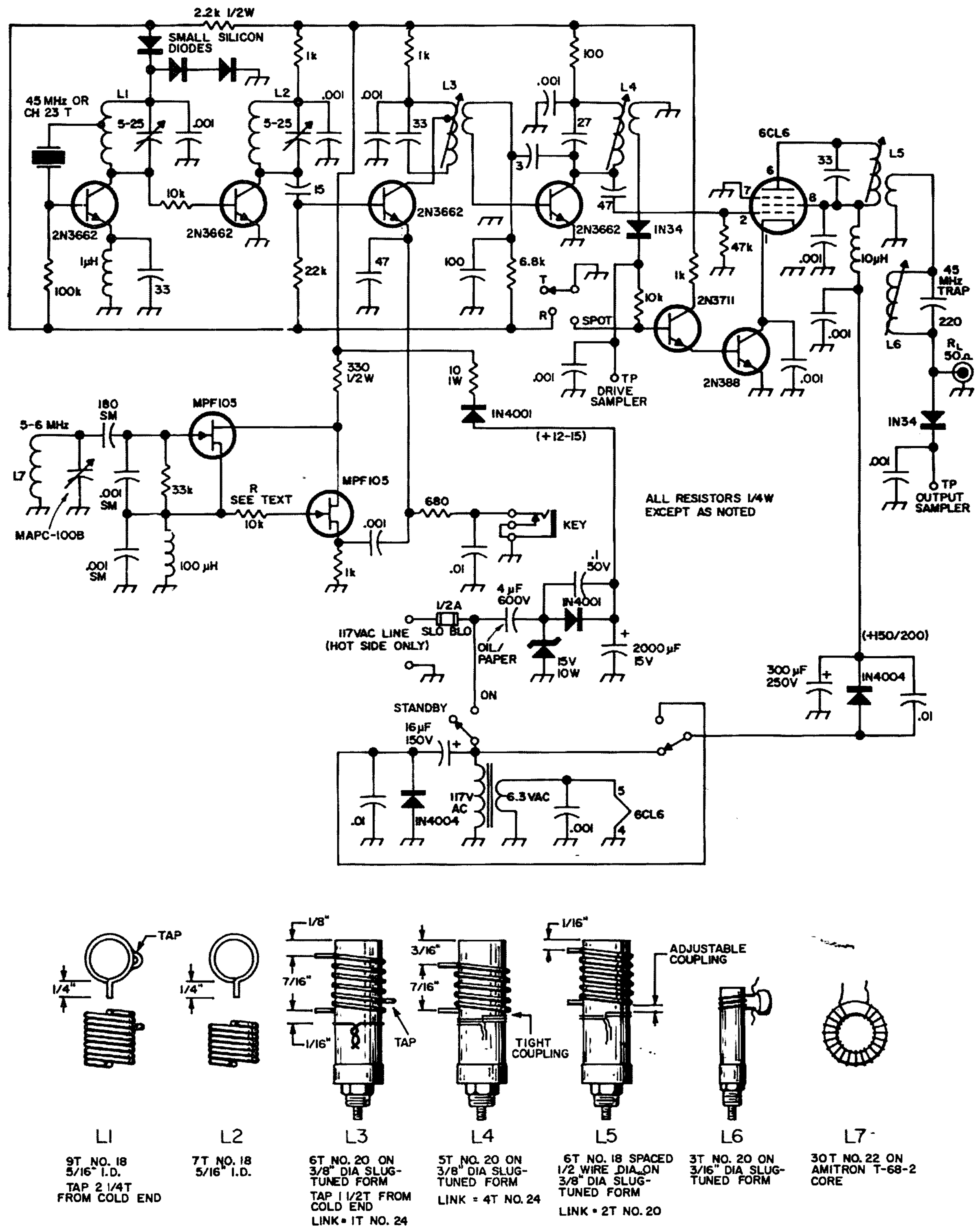

Fig. 1. Schematic and coil data.

lower like W1DTY. A 3N128 MOSFET circuit had a slight edge in smaller drift but an order of magnitude greater sensitivity to changes of B+ versus frequency (note double ft regulation in the original article). Caution *must* be observed during handling and an *rf* diode is required for class C bias. N channel JFET's tried were Siliconx E103 and Motorola MPF 103 thru 105, the latter being finally chosen. Good load isolation is provided by a FET buffer whose gate series resistor value is varied to optimize mixer emitter drive. A zener regulated B+ voltage is mostly to limit power input (and lessened warm-up drift) as the frequency versus voltage change is small. During test-

ing, without a zener, B+ was varied from 9 to 15 volts while the exciter supplied a carrier-reinsertion signal on a SSB station at 50.107, receiver mode being AM. There was no discernable change in voice pitch! A more critical test can be made by beating the fundamental VFO carrier around 5 MHz against a thoroughly stabilized 100 kHz marker in the receiver and adjusting for a low beat of about 1 Hz as indicated by the S meter. This resolution of a few parts in 10^7 shows up effects of B+, loading, temperature, etc. in a hurry.

Mixer performance was poor until collector tapping on its tank enabled a compromise between high Q, impedance matching and sufficient power gain. There was concern about VFO harmonics being amplified to a level where spurious emission would be unacceptable and in initial circuits tried this proved to be only too true. Also, a worse case condition occurs when a VFO harmonic coincides with a desired mixed frequency. A power ratio of only 13 db was obtained in one test; .5 watt carrier, 25 mw of 11th harmonic. Excessive mixer drive level was one reason but wave-form distortion in the VFO/buffer section was really at fault. Worse case spurious outputs in this finalized version are 50 db below a 1 watt carrier. This includes 45 MHz crystal feed-thru, the link trap having been set as described later on.

The straight-thru transistor buffer was impossible to stabilize by neutralization as first constructed and for some time a 330 ohm partial load on the sampler pick-up link was used to prevent self-oscillation. Shielding of low level stages to obtain final amplifier stability refocused attention on the "hot" buffer, where its instability might have been due to insufficient shielding also. Sure enough, bridge neutralization worked right off and energy lost in a swamping resistor now provides a well saturated grid drive.

Tubes tested for final amplifier use included 6EJ7, S686, 12BY7, 5763 and 6CL6 with the latter winning first place. Although its plate area is similar to a 5763, internal shielding is much better and gain at 50 MHz is good. Early tests indicated neutralization was in order because of persistant self-oscillation. However, after considerable electronic detective work, it was found that plate tank energy was radiating back into the sensitive low-level 45 MHz circuits, thus setting up a feedback loop required for oscillation. A simple metal shield completely enclosing these stages licked that problem for good and tuning thru plate tank resonance yields not the slightest trace of grid current variation. I suspect operation is in its self-neutralized frequency range which is a welcome bonus. No low frequency or VHF parasitics are in evidence either.

A Darlington transistor gate in series with the cathode performs like a screen grid clamper. 1 volt or more of dc applied to the 10 K resistor causes output transistor saturation and tube current is normal. When *rf* drive is zero (key up, mode switch on receive, spot, crystal out, etc.), sampler output is also zero and there is no forward bias. Transistor impedance becomes high causing tube current to fall, around 5 mils or less. This circuit also has an odd effect on tube current when mixer/driver tuning is varied. Plate mils start to climb with detuning until at 60 mils, sampler voltage is down to a volt and further detuning causes the current to drop rapidly towards zero. No *rf* drive and a dc cathode ground will cause tube dissipation to soar to 14 watts; 70 mils at 200 volts. Therefore this simple circuit should help to extend tube life under no-drive conditions. Perhaps it has possibilities as a cathode modulator if the exciter is run as a QRP rig.

For those who would like to duplicate this exciter, some construction hints are passed on. For L2, close wind 10 turns of insulated wire on a 5/16 form, remove and secure the turns with Duco or Ambroid cement. When set, unwind the ragged end turns and adjust according to coil data. Add a little cement where it tends to peel off. To tap L1, bare ½ inch of wire and bend it like a tiny inch worm. Sweat solder the loop closed then proceed like L2, winding in such a way that crystal socket connection and coil tap will be adjacent, with 2¼ turns between it and B+. For other coils, close wind tinned bus wire on a 11/32 form, adding extra turns. Remove from the form, stretch, then fully compress. It will spring open naturally after which it is slipped onto a ⅜ form by a slight unwinding process like a wrap-spring one way clutch. Self-tensioning will hold it in place while trimming to size and cementing. A few extra turns on the toroid will permit frequency adjustment later.

Locate the 2N3662 mixer buffer so that its collector lead can connect directly onto L4, insulated base lead projecting thru a

small hole for wiring to L3 drive link and emitter lead trimmed to 1/32 inch and grounded. Another small hole is required for the neutralization connection. Resistor leads running to +12 volts pass thru drilled holes whose ground foil side is chamferred back for insulating clearance. VFO and tube socket sub-assemblies are pre-wired before attachment to the main board.

Copper-clad printed circuit stock is just great for small rig construction; it provides wiring, insulated tie points, chassis, shielding and easy solder-ability all rolled into one! Finalized circuit board is number 4 of a series to be tried in the development of this exciter. Most leads are short and direct. Coil terminals are positioned for minimum lead length to concentrate inductance about the tuning slug. Double clad boards make it easy to apply B+ and ground for distribution of power about the "chassis." Insulated connections are made by cutting narrow channels thru the copper with a Moto-tool and small burr. Ceramic trimmer capacitors and crystal socket are epoxy-bonded in place.

One gallon anti-freeze or oil cans are a convenient source of metal for shielding. Paint remover such as TM-4 quickly removes labeling, leaving a bright tin-plated surface that solders readily. This was used for all metal work required in the exciter. A heat conducting tube shield is highly recommended. Tube socket chassis temperature is fairly high but it is just about ambient near the crystal and VFO area using either horizontal or vertical mounting (tube uppermost).

Initial tune-up and check out should adhere to the following schedule. Connect a jumper wire between pin 1 of the tube socket and ground. For ease of removal during test and trouble shooting, just tack solder the low level circuit shield to ground at each corner. Install a 6CL6 and its shield but do not energize. "Kill" the VFO by shorting its tuning capacitor plates with a bare wire and do not install a crystal. Connect a low current voltmeter such as a Simpson 260 to the drive sampler test point. Apply +12/15 volts at about 40 mils to "Lo B+" and vary all tuning adjustments in a random manner in an attempt to start parasitic oscillations. Zero meter reading indicates all is well and this must prevail before proceeding. A change of neutralizing capacitor value might be required; its value is fairly non-critical however.

Install a crystal and tune the crystal oscillator, buffer, mixer and mixer buffer to its frequency around 45 MHz as indicated by a reading of 2 to 3 volts dc. Operate the mode switch and optimize oscillator tuning for positive starting with best output. Now, enable the VFO. Notice little or no change of meter reading. Mixer and mixer buffer slugs are then backed out a few turns, peaking up on a similar meter reading with output now at 50 MHz. VFO low limit and frequency range may now be set by appropriate adjustment of toroid inductance and the series padding capacitor. This particular rig tunes 50.15 to 51.4 MHz.

50 db of signal/spurious ratio demands nearly ideal mixer operation but it is easily checked. With tuning adjusted as described, zero VFO output should result in a reading of about .1 volt which is crystal feed-thru. With crystal out and VFO running, try peaking up on an in-band harmonic using the station receiver and its S meter. There will be some transistor "white" noise along with a small signal (about S7) but no dc volts on the meter. Variation of the FET buffer gate resistor gave results as shown.

R	DC Meter	S Meter
4.7k	70 mv	+40
6.8k	20 mv	+20
8.2k	trace	S9
10k	none	S7
VFO plus	crystal	(crystal out)
8.2k	3.2v	S9
10k	2.8v	S7
18k	1.7v	S6
33k	1.0v	S3
open	.4v	S3

Just a few minutes is required to run a test like this and it enables a best choice of resistor R, in this case 10K. Only if transistors are changed need it be repeated, being a set-and-forget adjustment.

With the solid state circuits squared away, final amplifier tune-up is next. Connect a 50 ohm dummy load to the output BNC. Disable the VFO and retune all slugs to crystal frequency. Move meter, 10 volt scale, to the output sampler and energize the tube. Peak all tanks, about 8/10 volts indicated then carefully resonate the trap for best null, around a volt or so. Do not alter its tuning unless a different crystal is used. It provides a 22 db reduction in spurious feed-

thru. Back out tuning slugs a few turns, enable the VFO and tune up on 50 MHz for a meter reading of about 10 volts (B+ at 160 volts.) Verify the signal as being in-band with a wavemeter, receiver, etc.

Leave all power on and stop the VFO. There should be zero volts at the final sampler, again .1 volt of drive sampler output. Crystal removal drops this to zero also. Check for parasitic oscillations by random tuning of all slugs; sampler outputs must remain at zero, tube current steady at 70 mils. With VFO running, once again try to peak up on an in-band harmonic. Results should be similar to the previous test, no sampler outputs, noise and signal somewhat higher due to tube amplification. Its a bit rough on the "bottle" but generates lots of confidence in exciter stability and insures a clean signal.

Finally, retune for proper operation on 6, remove the cathode ground wire and check out gate performance. For tripling to 2 meters, output at 48 MHz may be obtained by using a 43 MHz rock, remembering to retune the trap. Always keep in mind that *correct* tuning means: "No VFO output —no final output." Tube output will stay high if the VFO is stopped and incorrect tune-up was made on crystal frequency. Pulling the crystal is *not* a valid test; output will be zero in either case.

The exciter with +160 volts on the plate will drive an 829B to 12 grid mils thru a 5.6K grid bias resistor. The previous battery tube version with its fancy regulated power supply for filaments and plates driving a 5763 buffer produced 8 mils. At maximum tube dissipation, +200 volts will yield a 1 watt output.

From a cold start, drift is about 300 Hz in 15 minutes settling down to something like 35 Hz per hour thereafter. This would seem to be acceptable performance for portable or mobile use. For home station use, warm-up drift may be eliminated entirely by continuously powering the transistor section; a novel power supply is suggested. It will maintain B+ witahin a .2 volt for line voltage excursions of 85 to 135 volts, is short-circuit proof and draws less power than an electric clock in the standby mode. The VFO may be enclosed in rigid foam plastic for ambient temperature smoothing as the coil and capacitor have non-zero temperature coefficients. Its output may then

be applied to the mixer emitter thru a length of shielded wire.

It is hoped that this little heterodyne VFO rig will appeal to many of the 6 meter gang. Since its absolute stability is good, operation on hf bands via a power mixer could be used to heterodyne *down*. For 10 meters, 50.5 MHz beating with 21.5 MHz to get 29.0 MHz, as an example. Low budget hams can shop around for bargains from Meshna, Poly-Paks, etc. and build it for about 20 dollars. Surplus scroungers with fat junk boxes could cut that figure in half. Its quite possible other high frequency transistors would perform as well or better than 2N3662's. A couple of 2N918's tried worked fine. Rag chewers will appreciate its stable operation, running for hours on end without distress. Frequency hoppers can adjust the tuning for flat output over a few hundred kHz or full spread with slight touch-ups of slugs, mostly the sharply tuned mixer. Inveterate tinkerers will note a polarity reversal protection diode, current limiting resistors to prevent sudden death of a transistor should a test prod slip and an oddball regulated power supply which keeps its cool when shorted, trying only to improve 117 volt line power factor. And if you're "hooked" on frequency stability like me the exciter comes close to state of the art for LC oscillators!

The "do-it-yourself" adjustment and tune-up technique was cross checked on a spectrum analyzer in the lab. Using a 1 watt carrier for O db, crystal feed thru measured −51 db worse case VFO harmonic −53 db and circuit noise −60 db. A couple of CB crystals could be made to "twin", a double mode oscillation heard as an audio tone on the carrier; a slight retuning of the crystal tank stopped it.

In conclusion, a tipe of the ole fedora to K1CLL, W1DTY, W2YM and others whose previously published accounts got this project off to a flying start and to Mrs. Bob Trefry for yeoman effort with her typewriter.

. . . W1KNI

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2 Slippery Six 73 Nov. 1965
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Appliance Operators— Please Turn Page

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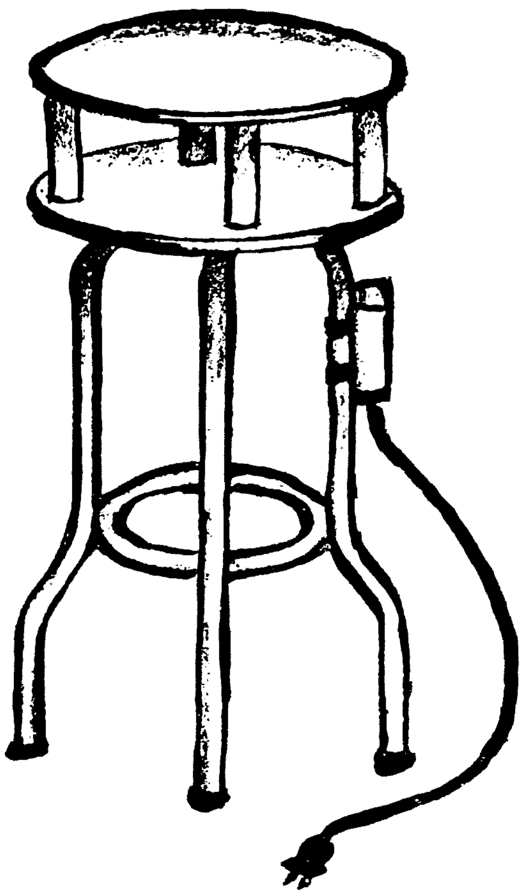


How many times have you wanted to monitor for a band opening on VHF; waited your turn on the net or just wanted to rag-chew and at the same time be able to catch up on a favorite home brew project?

Normally the average shack does not have bench space at the operating location to permit such a situation.

This project provides for a simple, inexpensive bench, which is portable, and provides for rotation of the bench top to simplify turning of a chassis as well as providing for parts and tool space close at hand.

If you are an avid home-brew fan, read on.

Keep a weather-eye out for a bar or counter stool of the chrome tubing type with swivel top. These normally have a ball bearing base to the seat which is approximately six to eight inches in diameter and permits 360° rotation of the seat. Remove the wood screws which secure the seat to the bearing plate and your project is well on the way to completion.

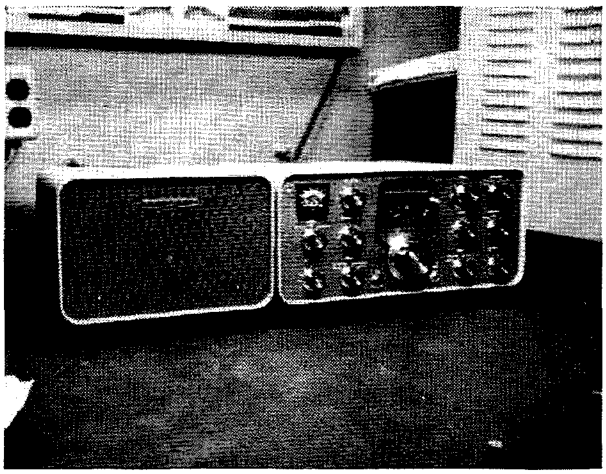
Cut two eighteen inch diameter pieces of one-half inch plywood (or other size as desired) and finish with paint, varnish or shellac. Cut four pieces of one-and-one-quarter inch closet pole (soft pine) or square stock, six to eight inches in length and finish in same manner as plywood. Secure the closet pole pieces to the plywood with wood screws about one-half inch from the outer edge at the quarter points in such a manner as to provide two round shelves spaced six or eight inches apart. Place the completed shelf assembly on the floor and invert the stool on the shelf assembly; locate on the center lines and secure the stool to the shelves with appropriate wood screws. The completed "bench" can be provided with an electric outlet, mounted on one leg, for soldering gun or iron, with "patch-cord" to the nearest convenient outlet. A small vise can be mounted on the lower shelf to assist in holding these small parts "too hot to handle" when soldering. The lower shelf affords storage for tools and parts while the top shelf becomes a rotatable bench for the chassis, rig or what have you. Procure a three quarter inch pad of foam rubber or plastic to use as protection when working on panels or components which may be scratched by a hard surface.

Note: This project is not compatible with a reclining type lounge chair.

Mexican Licenses

Mexico seems to have relaxed a bit on amateur radio licenses and you may be able to get one if you are planning a trip down that way. The open door border has been strained by an influx of hippies and weirdos from our country and now it is necessary to get a Tourist Card from a Mexican Consulate before crossing the border.

A Review of the Heathkit SB-110A



Matthew T. Lewis DS2
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Want a really great transceiver for six meter SSB? Then this is the one! Assembly takes about thirty to thirty-five hours, and the most difficult step is stringing the dial cord for the final loading. This took me about fifteen minutes of trial and error, mostly error.

A look at the instruction manual will show that all printed circuit boards (six in all) are assembled first. All parts for these are packed in a separate box, so one box is all that should be opened at the start. Assembly of the PC boards, which appear to be of high quality, takes about five or six hours for all of them, including counting and sorting parts prior to starting.

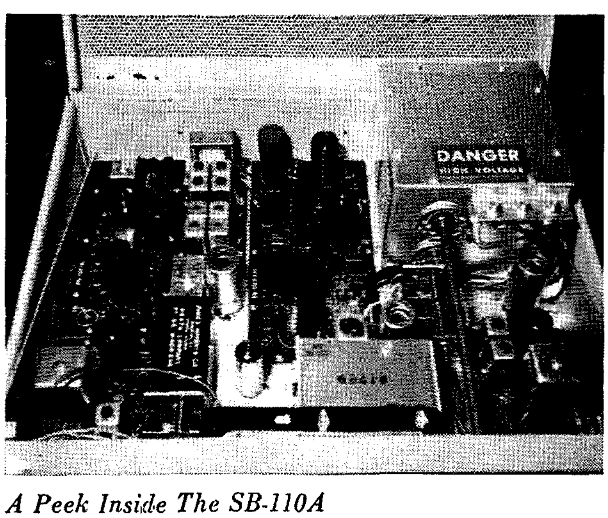
All instructions are very specific, and easy to follow. The boards are also marked on the component side with parts values, so it is very difficult to make any errors, except by carelessness. When all boards are completed (one resistor is left off the receiver RF board for later installation) they are set aside for later use.

Next comes the installation of parts onto the chassis. For this, the chassis is divided into twelve sections, six on the top and six more on the bottom. After a good portion of the parts are installed, including the PC boards, the final stage wiring is begun. Next comes the wiring harness, which is made by Heath, thankfully. A few wires must be trimmed to provide hook-up wire for later use, but all others are precut to the correct length and stripped. After the wiring harness is in, and partially wired, the coax harness is installed (also precut and stripped). Wires are soldered to the foil side of the PC boards, and the remaining parts are installed. All of this is very easy, due to the excellent drawings and detailed insets in the book.

When construction is complete, before alignment, you will have two resistors left over. *Don't worry about it.* The 47 ohm half watt is used for alignment only, and the 33k two watt is installed in the receiver *rf* stage, after neutralization.

Next comes the alignment. The only test equipment required is an eleven megohm VTVM (or solid state voltmeter, I used the IM-17), a fifty ohm dummy load (light bulbs are no good), and a receiver capable of receiving WWV or a broadcast station on a multiple of 100 kHz.

Some nice features of the SB-110A are its ability to use crystal control for transmit or transceive, with front panel selection, the crystal socket is inside and it takes a crystal in the 4.975-5.525 MHz; the built in



A Peek Inside The SB-110A

100 kHZ calibrator; two antenna connectors on the rear apron, one for the transmitter and one for the receiver, or use the internal relay; phone patch input; ALC input; a spare phono jack for whatever you want (*if* out for a monitor scope, etc.); and a spare hole which will take a phone jack, this is used for a brass bushing when used with the mobile mount. There is also a set of relay contacts which close on transmit, brought out to the power plug. A CW sidetone generator is included which provides about an 800 Hz. tone and has its own level control (internal). In the CW mode, the receiver is in the USB mode, and the transmitter uses an offset crystal for carrier generation, which bypasses the balanced modulator, so when you tune a CW signal for an 800 Hz. note, you will be close to zero beat with him. The SB-110A also has an excellent noise limiter which is turned on by pulling out the audio gain control. The AGC is normally fast, but pulling out the *rf* gain control adds .2 mfd, which slows it down considerably.

Unfortunately, Heath included no provision for AM operation. However, if AM is really desired, the carrier null adjust pot inside could be adjusted for about 50-75 watts carrier input, and the microphone level cut down to prevent "overmodulation". This will give you carrier and one sideband, but there is no way to turn off the receiver BFO.

The crystal control feature is quite nice, as it allows split frequency operation for DX chasing, or crystal controlled tranceive for net operation. There is an internal trimmer to "rubber" the crystal slightly and get exactly on the desired frequency. It appears that minor rewiring is all that would be required to use the SB-640 external LMO which was designed for use with the SB-101, but Heath has no comment in their ads. However, page 99 of the instruction book shows an external VFO connected to the spare phono jack.

When the SB-110A is completed, all that is needed to get on the air is a power supply, a speaker or phones, an antenna, and a key or microphone (Amphenol 80MC2M connector furnished with kit). The recommended power supplies are the HP-13 for mobile (12 VDC) and the HP-23 (117 VAC) which fits quite nicely into the back of the matching SB-600 speaker.

As far as performance goes, the SB-110A far exceedes the Heath spec sheet. I measured 10 db S+N/N at .05 microvolts using an AN/URM-26G and a Simpson 260, and the CW output is slightly over 100 watts measured with a Bird thru-line wattmeter into a fifty ohm load.

In summing up, although I found the SB-110A easy to build, I don't recommend it for anyone who has never built a kit before. Start off with something a little easier, like a Twoer or the power supply you plan to use. Or try the IM-17 solid state multimeter if you don't have a VTVM; for twenty bucks, you can't go wrong. All in all an outstanding rig for the serious six meter SSB man, who wants an easy to operate, well performing rig with a very pleasing appearance, and a reasonable price tag. See you on six.

. . . WA2ZSA

Six Meter Transceiver

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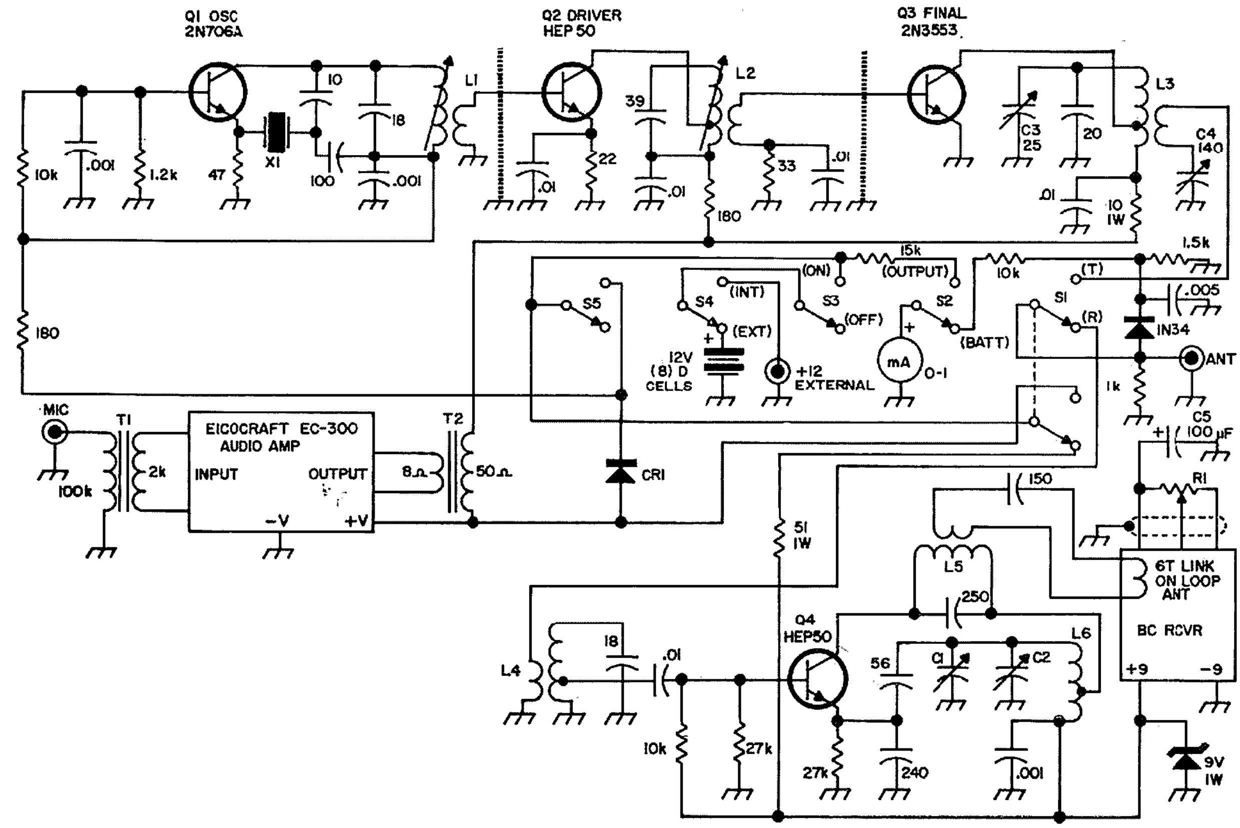


Fig. 1. Schematic diagram

Here is one way to get on six meters without spending a lot of bucks. In the process you can have a lot of fun building your own rig and, if you are one of the uninitiated, take the plunge into transistor circuitry.

You have probably already looked at the transceiver diagram, **Fig 1**, and I expect that your reaction was "boy, that looks simple." Well, this rig was intended to be simple and inexpensive. The transmitter power input was kept low—2 watts—more than adequate to give good local coverage. The low power also means the rig can be run off Size "D" flashlight batteries keeping the weight down (5½ lbs.). This along with the small size makes it a dandy rig for portable and/or emergency use. An rf amplifier was not used ahead of the receiver mixer in order to keep the cost down. The rf amplifier is not needed for local activity anyway.

General construction

The transceiver is built in two 7 x 5 x 3 aluminum miniboxes (Bud # 3008A) butted back to back so that you end up with a front and rear compartment. The front compartment houses the converter, transmitter, modulator and has all of the controls, with the exception of the power selection, mounted on the cover. The microphone socket, on/off volume control and spot switch are mounted on a small bracket positioned so they protrude thru the front panel when it is assembled to the front minibox. The rear compartment houses the BC receiver, modulation transformer and battery pack.

The power selection switch and socket for external power are mounted on the rear cover.

The antenna socket is mounted on the top right end of the front box. Two holes near the antenna socket allow access to the transmitter amplifier tuning and loading controls.

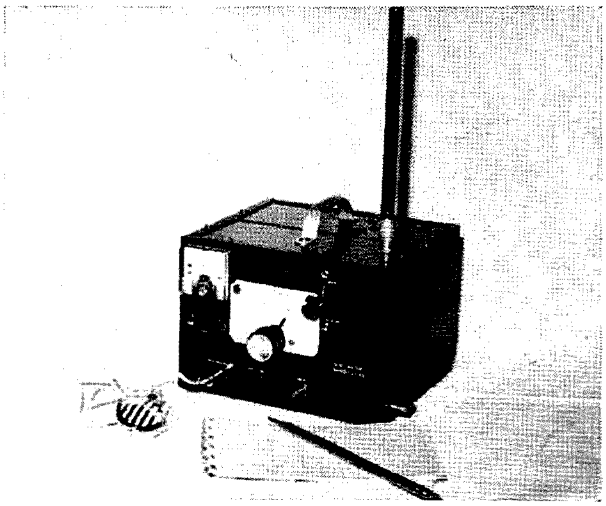
The only luxury in the transceiver is the meter that is used to measure either battery voltage or rf output depending on the setting of S2. Actually the meter is well worth the investment considering the speed it allows in determining battery condition and ease of transmitter adjustment with different antennas.

SI switches the transceiver between transmit and receive mode. S1A switches the antenna and SIB switches the dc voltage. S5 turns on the transmitter oscillator for frequency spotting.

Chasis layouts are shown in **Fig. 2** for the converter and transmitter exactly as I built them. They are the only units that may be critical in the transceiver and are therefore the only layouts shown. The arrangement of all units as to their position in the transceiver was not found to be critical so a detail layout of the entire transceiver was not prepared. The final locations will probably be determined by ease of operation and by best utilization of space. In any case the two Bud cabinets specified have plenty of room in them.

The receiver

The receiver is made up of two basic parts; a commercial transistor receiver (Japanese variety \$5 to \$8) and a one transistor, Q4, combination oscillator/mixer/converter. The converter operates on the autodyn principle, L6 setting the oscillator frequency at one half the operating frequency. In this case the oscillator tunes 24.195 MHz to 25.195 MHz to cover the receiver range of 50 to 52 MHz. The output of the converter is approximately 1610 kHz. The transistor receiver is used as the *if* amplifier, detector and audio output amplifier and is tuned to the converter output frequency of 1610 kHz. Coupling between the converter and receiver is accomplished by a six turn link wound over the center of the bc set ferrite loop antenna. This link is connected to the 3 turn link over the center of L5 by a 150 pF capacitor. The 150 pF capacitor prevents any chance of too tight a coupling and subsequent pulling of the bc set oscillator frequency. Do not use shielded wire for the connecting twisted pair.

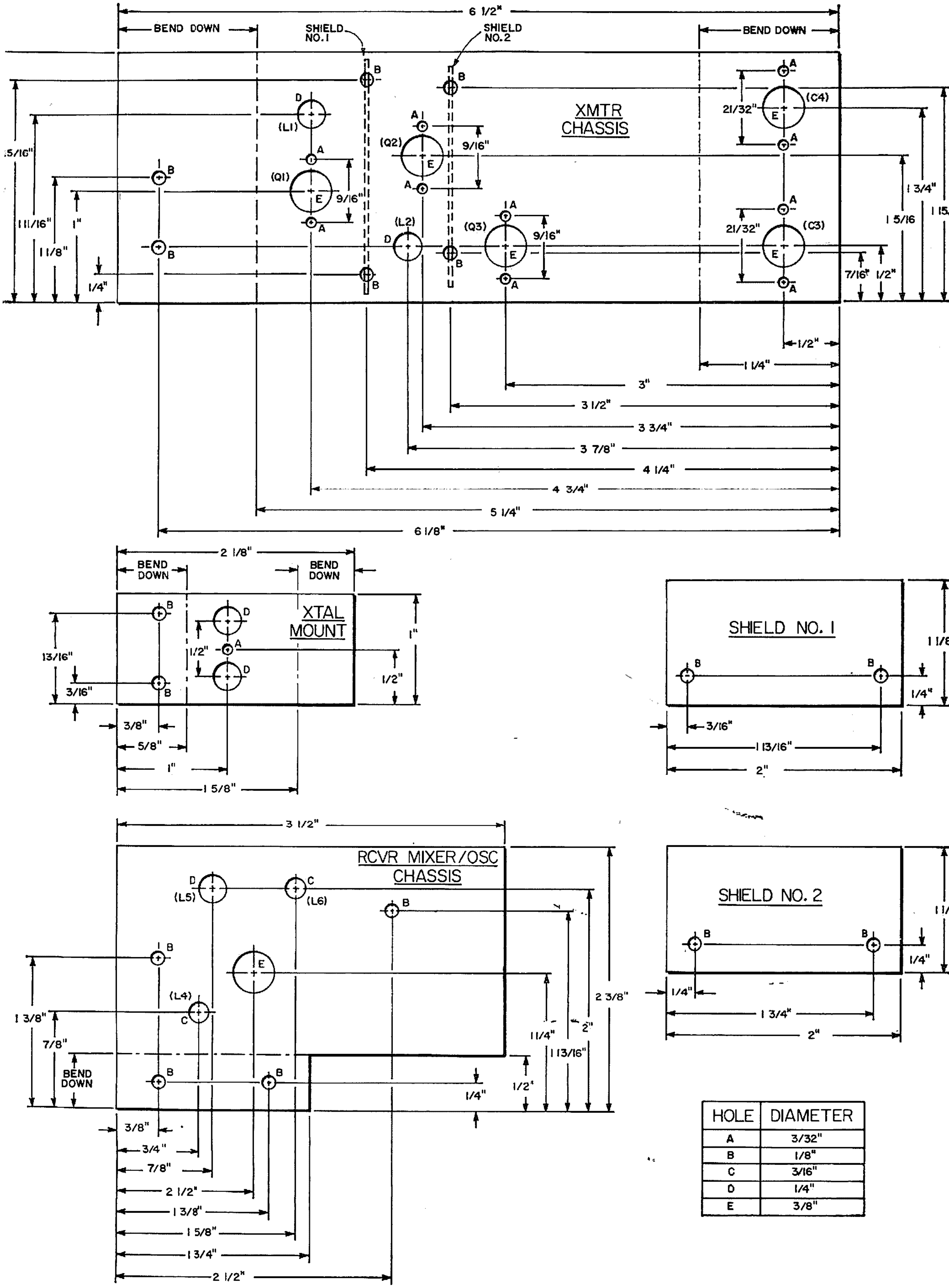


Six Meter Transceiver—Controls, bottom left to right; microphone, on/off volume, spot: center left to right; meter switch (DC-RF), receiver tuning, send/receive switch. Antenna shown is a collapsable "CB" replacement type and is mounted with a PL-259 to Phono adapter. Note crystal mounting thru lower right side. Speaker opening cut in top right rear compartment.

L5 is constructed by winding one full length (about 45 turns) of #26 wire on the form, applying a layer of plastic electrical tape, then winding the second layer of 30 turns. L5 resonates to the converter output frequency of 1610 kHz.

Because the bc set is mounted in the rear compartment it is necessary to install an external volume control. The new volume control and switch is connected as follows:

1. Remove the two wires going to the switch of the old bc set volume control and solder them together.
2. Remove the three wires going to the resistance element of the old volume control and connect them to the three inner condustors of a length (about 8 inches) of three conductor shielded cable.
3. Connect the other ends of the three inner conductors to like terminals of the new volume control. The shield should be grounded to the chassis near the new volume control. The shield is not connected to anything at the end in the bc set.
4. The on/off switch on the new volume control should be wired as per **Fig. 1.**



HOLE	DIAMETER
A	3/32"
B	1/8"
C	3/16"
D	1/4"
E	3/8"

Fig. 2. Chassis Layout

Receiver adjustment

Use a grid dip meter to adjust L4 to 41 MHz, L6 to 25 MHz and L5 to 1.6 MHz for a starter. Tune the bc set to a dead spot between bc stations near 1.6 MHz. Because of the lack of shielding in this type of bc set harmonics of the bc set oscillator will be coupled into the 50 MHz converter thru the twisted pair connecting link. With a converter tunning range of 50 to 52 MHz you are bound to get one of those harmonics. By keeping the bc set tuned between 1.6 and 1.62 that harmonic should show up near the 52 MHz end and won't be a problem.

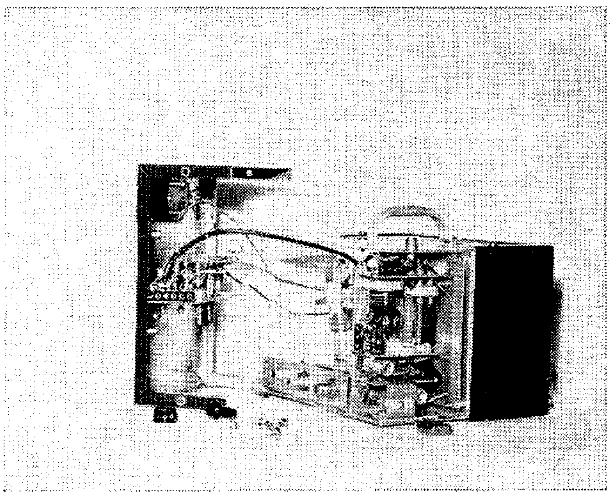
The next step is to couple a signal into L4 and adjust alternately L6 and C1 trimmer until the range of 50 to 52 MHz can be covered by tuning C2.

If you intend to use the entire range of 50 to 52 MHz set the signal source to 51 MHz and adjust L4 and L5 for maximum output from the bc set. If most of your operation will be in the first 1 MHz of the six meter band set the signal source to 50.5 MHz and tune L4 and L5 for maximum output.

The transmitter

The transmitter is constructed on a 4 x 2¼ inch piece of .04 inch thick aluminum with two 1¼ inch lips folded down a both ends. The shields are held in place with spade lugs and have a ⅜ inch hole drilled through them for signal feed through to the next stage.

The oscillator, Q1, uses overtone crystals, feeds Q2 which is a straight thru driver for the final, Q3. Either 2N706's or HEP-50's can be used for the oscillator and driver. The prices aren't bad, $ .99 for the 2N706 and $ .79 for the HEP-50. The final uses a 2N3553 which costs about $4.75. The 2N3553 has a Collector to Emitter Voltage rating of 65 volts which is required for amplitude modulation of the final (with a 12 volt supply the collector voltage on modulation peaks can reach 48 volts). The 180 ohm resistor in the collector lead of the driver Q2 limits the peak voltage to that stage on modulation peaks. With the arrangement shown 80-90% modulation can be achieved. If 100% modulation is required the 180 ohm collector lead resistor to Q2 can be eliminated, however, Q2 will have to be replaced with a transistor that will handle the 48 volt modulation peaks. On



Front compartment with "U" cover removed showing; 1. In lower center the bracket used to mount the microphone jack, on/off volume control and spot switch, 2, on right the transmitter mounting and crystal mounting bracket. Note the modulator printed circuit board mounted on compartment back just behind the transmitter, 3. center left the converter sub chassis.

the air checks with other stations indicate that the modulation, as set up in **Fig. 1,** was adequate. Both Q2 and Q3 require heat sinks.

The transmitter was mounted in the front compartment with the bottom or wiring side facing to the right. This allows access to the circuitry for checking and possible trouble shooting after the chassis is mounted. The coil slugs are accessible thru the bottom of the forms. An insulated tool should be used for tuning. A bracket is formed for the crystal socket. This bracket mounts on the bottom of the transmitter chassis over the oscillator wiring and makes it possible to change crystals thru a hole cut in the right side of the cabinet.

L3 is a self-supporting coil made of #18 wire. The two turn link is made of #22 solid insulated wire. The link can be best made by taking two turns around the shank of a ½ inch drill then twisting the ends of the wire a couple of times next to the turns. The link is inserted between the 1st and 2nd turns of L3 from ground end and is held in place with a couple of drops of glue.

Transmitter Adjustment

L1, L2 and L3 should be grid dipped to 50 MHz. If you can't get a good dip on L2, temporarily remove Q3 from it's socket. If possible do the initial tune up with a 10

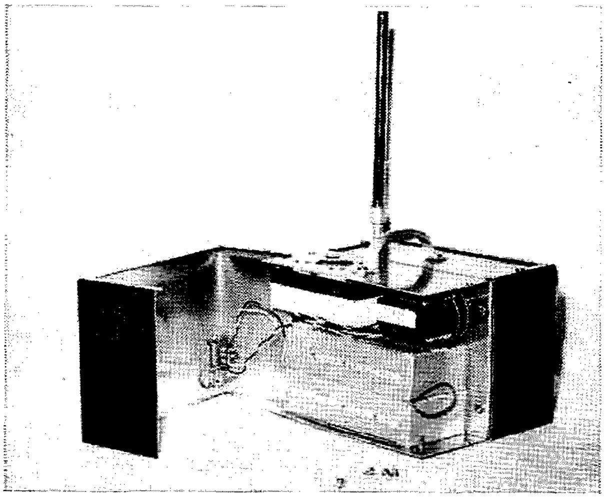
volt supply. There is less chance of damaging the transistors at that voltage. Apply power to the oscillator by depressing the spot switch S5 and check with a grid dip meter to make sure Q1 is oscillating. If Q1 does not oscillate adjust L1 until it does. At this point you should be able to tune in the oscillator signal with the converter whenever S5 is held depressed.

Connect a dummy load to the antenna jack. This can be a 51 or 75 ohm 2 watt resistor. Turn SI to transmit and tune L2, C3 and C4 for maximum reading on the output meter MI. Then go back and adjust LI for maximum output on MI. Turn S1 back and forth between transmit and receive several times to make sure L1 is adjusted properly for easy oscillation.

The modulator

The modulator is an Eicocraft EC-300 2 watt autio amplifier kit and sells for $4.95. At that price it is hardly worthwhile to design and build your own. The input impedence is 2k ohms and is matched to a high impedence crystal mike by T1. T1 isolates the amplifier common, which is at a plus voltage, from the transceiver ground system. No form of gain control was needed as the amplifier output was just right with it running wide open. The microphone used with the transceiver is a lapel mike (Lafayette 99H4510) and does a pretty good job for $1.95.

The output of the amplifier is 8 ohms and is matched to the approximately 50 ohm input of the final by reverse connecting a Knight 54B4149. The common and 8 ohm tap connect to the amplifier output and one side of the secondary, and center tap are used to obtain 50 ohms for feeding the transmitter.



Rear compartment with "U" cover (holding power select switch and external power receptical) removed showing location of BC set, modulation transformer and battery pack.

The Eicocraft comes with mounting screws and spacers. This hardware is used to mount the circuit board to the rear of the front compartment behind the transmitter chassis. The spacers provided are not very long so care should be used to make sure all leads on the bottom of the circuit board are trimmed closely.

Conclusion

The converter tuning capacitor is fitted with a Jackson Bros. #4511 vernier drive for smooth operation (available from Arrow Electronics Inc.). The dial plate is a piece of .04 inch thick aluminum 2 x 3 inches that was painted and numbered by using Datak instant lettering.

the transceiver has a built in power supply of 8 series wired Size "D" flashlight cells. A switch and socket is mounted on the rear cover so that an external power supply can be used. This could either be a car battery (plug in cigarette lighter) or a 115Vac supply. If continued portable use is anticipated it would be worthwhile to invest in Nickel Cadmium batteries and build a charger.

Power consumption under three different voltage inputs are:

Voltage	Total input	Final input
10	.35 amp	.18 amp
11	.40 amp	.22 amp
12	.45 amp	.24 amp

In receive mode the transceiver draws between .04 and .05 amp.

The transmitter output circuit is designed for 52 to 72 ohms and can be operated with either a whip for portable use or a beam. A whip should only be used when necessary because of the limited coverage. If a portable beam is not available when operating portable, say from a mountain top, a long wire with a simple tuner will work out much better than a whip.

So there you are—if you want to get your "feet wet" on transistors and also get together with the gang on the local six meter net go to it. I'm sure you will get as much fun and accomplishment out of it as I did.

. . . W2AJW

Rejuvenating Old RTTY Ribbons

Is your typewriter or teleprinter ribbon getting old and run down? Does it print dimly and sometimes not at all? Here is a simple remedy.

The first step is to wind all of the ribbon onto one of the spools in the machine. Then remove the ribbon and both spools from the machine and rewind it by hand, feeding it a few drops of oil (ordinary machine oil or SAE-10 motor oil). Put a good sized drop or several drops about every inch or half inch of ribbon as you rewind. The amount of oil needed will depend upon how dried-out the ribbon is to start with.

After oiling, rewind onto the first spool without adding any more oil. Keep the ribbon fairly tight on the spool as you wind. This tends to force the oil into all parts of the ribbon and distributes it evenly.

Now replace the ribbon in the machine and test it by typing with it. If you have too much oil on the ribbon it will type rather messily, but if not enough oil it will print dimly.

Another tip: ribbons which are used in adding machines, posting machines and other office machines other than typewriters seem to be of better quality and last longer than regular typewriter ribbons. Most users of these machines will give you their discarded ribbons. Since adding machines and such use only one half of the ribbon anyway, a discarded ribbon still has half of its useful life ahead of it. When purchasing a new ribbon it would be good economy to buy one designed for adding or posting machine service.

Joe Wright W5AQN

Two Sidebands From The TWOER

Ralph W. Campbell W4KAE
316 Mariemont Drive
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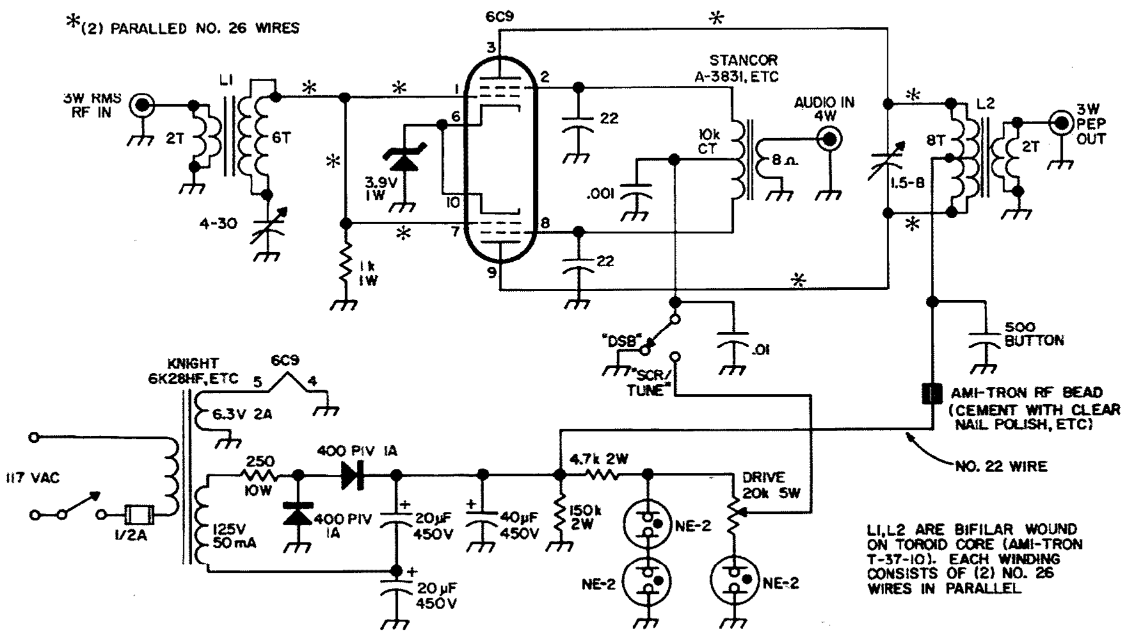


Fig. 1. Diagram showing all parts and connections.

This article tells the story of a simple way to build a 2 meter sideband rig. All you need is a Two'er or similar piece of equipment, furnishing 2 or 3 watts of rf output; and a 5 watt amplifier, such as the Lafayette KT-92. A mike preamp will help you get 4 or more watts output from this.

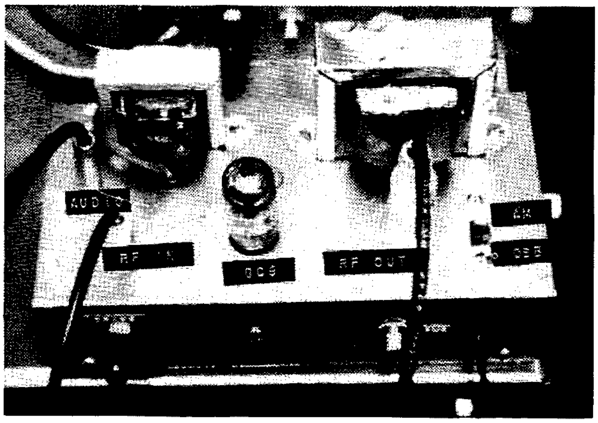
The double-sideband output of the unit described is nominally 3 watts PEP. If you are careful, there is enough power available for driving an Amperex 4CX250 or similar beam tetrode using a shielded, high-Q input tank circuit. If you're driving two of these tubes add a 6360 in class AB_1 (or B) as an intermediate power amplifier and use the drive control as we have outlined here. As a sort of rule-of-thumb, this unit will supply about 1 RMS watt to the grid of the next stage. Also, do not feel that you will be losing something by going to DSB! That's not the case. With the 6C9 balanced modulator you can select either high efficiency, well modulated AM, or DSB with real punch!

The operating classes are AB_2 for AM carrier plus screenfed audio (AB_1, if you don't drive it so hard); and class B for the DSB mode. Incidently, AB_2 linear operation is possible with the Two'er, but not recommended since there is "multiplied hum" and fragments of 60 Hz ac present in the output. We do not make DSB out of existing AM from the Two'er, in case you're wondering. Separate audio derived from the 12AX7 and 6AQ5 in this commercial unit will not have enough power as when an outboard audio amplifier is used. Try it though, if your curiosity is not satisfied. With just one tube and an audio amp, you'll soon be known as a "genius" if you get on 2 meter DSB without some 47 different kinds of transverters and a degree from No-Hope-Tech! We *do* use a zener diode if you want to bamboozle 'em a little. Operation is, as we said, either AM or DSB with some grid current being drawn.

Negligable distortion is present when a 1000 ohm 1 watt composition resistor swamps the grid input winding, but it is necessary to go to 2 watts when driving the modula-

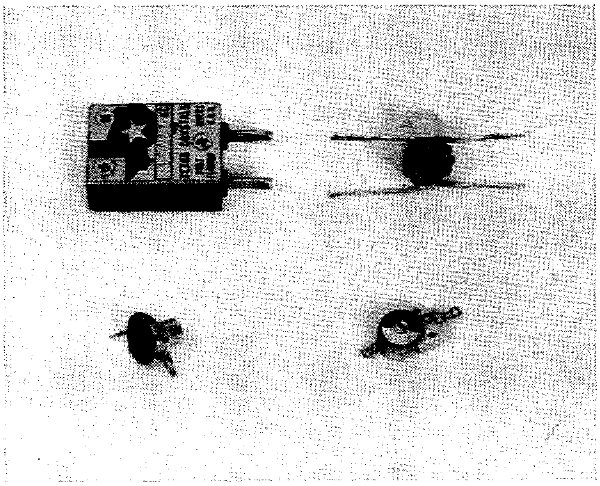
tor with more than 5 watts dc input to the preceding stage. And, probably a higher-valued zener, such as the HEP-103 will be necessary. Here we use an International Rectifier 1 watt 3.9 volt job. Incidently, the correct class A bias for the 6C9 is about minus one volt, so for DSB driving the tube with rf at an average value of −4 volts is quite acceptable. Peak-to-peak swing is about 9 volts, with no more than a small fraction of a peak in the positive grid region. Power in excess of 3 watts will be dissipated chiefly by the control grid (when driven positive), so watch it when using anything larger than a Two'er for drive.

An interesting point is that there is negative current feedback, or degeneration, through the zener for negative audio peaks and this tends to improve the audio fidelity; rf having been safely bypassed to ground through junction capacity. On AM mode screen modulation, using a Cesco Reflectoometer in the output line as a tuning/SWR device; we see upward modulation when flat-topping the audio in class AB_2. Simply reduce the audio gain to a point where only when shouting into the mike at 2 inches will produce this symptom (use a dummy load): then relax and talk normally, and no one will know that it is zener offset positive peaked AM!! Of course a scope will come in handy here for setting it properly!



Construction

The first photo shows parts placement on the bright nickel plated steel chassis, with the screen voltage or drive control on the left. Just behind this pot on top of the chassis is an rf coax termination, using approximately 1 yard of RG-58/U coax cable attached to the phono connector output of the Two'er. The Two'er was previously wired for driver plate current to flow through the 350 ohm dc coil desistance of the Dow-Key



DK-60 send/receive relay, with the 1000 ohm internal dropping resistor removed. This way, the switch on Two'er panel serves as *the* control for all circuits and external contacts on the DK-60 relay open the speaker return on transmit: of the *if* strip used.

Getting back to the modulator. Just behind the termination is an audio input connector patching the KT-92 amp into the VC to 10K CT 5 watt Stancor A-3831 audio transformer. With the tap on the transformer set to a nominal 8 ohms will give good quality audio (almost broadcast quality) if you don't overdrive it! Also, for improved fidelity it is desirable to feed 4 ohm output (or 3.2) from the amp into 8 ohms, but not vice versa, with a power loss. Please note also that if you're using a KT-92: this is an ac-dc type amp with floating ground and plug phasing is important to avoid electrical shock when used with other grounded equipment. Remove the Two'er audio section, after experimenting, to prevent weird results using the balanced modulator in DSB with AM on what is left of the phased-out carrier. Yanking the tubes out (carefully) will do this. Next we see the 6C9 tube in the center with the power transformer behind and a type 60P UHF panel receptacle.

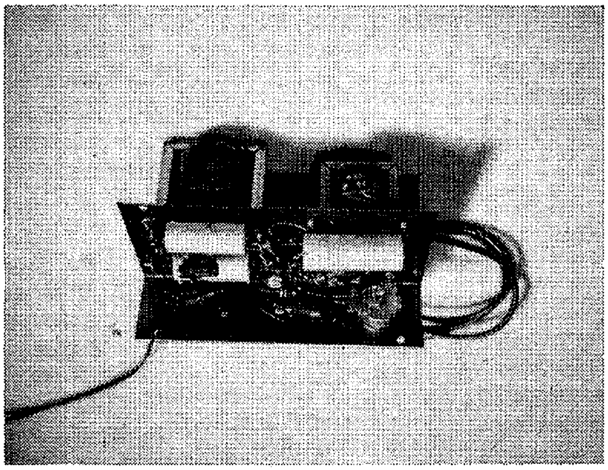
The next photo shows the miniature toroidal tank circuits before they were mounted to the chassis underside with epoxy cement. An FT-243 crystal holder is used to reference the size of the components involved. The left (LI) tank is a bifilar 6 to 2 of #26 Beldsol wired toroid, with an Erie 15-60 PF N1500 trimmer capacitor; and is tuned only by the 2 turn series input capacitor just mentioned, which makes the left (grid) winding into a form of autotransformer for rf. Later on the Q dropped in this circuit

with mechanical tuning adjustments: so we went to an 822EN CRL trimmer. The righthand (L2) tuned circuit uses another toroidal rf tank, wound on an Ami-Tron T-37-10 core, push-pull balanced to single turn output coupling. Both tanks are bifilar wound. Do not use wire any heavier than #24 Beldsol or you *will* break the core! And, it is academic if you'll raise the Q much higher with bigger wire, because circulating current losses may defeat any gain over skin effect at these frequencies.

An important thing here is that we used material type #12* (Carbonyl SF) cores purposely to "keep the field within the core," at a reasonable Q, compared with air-winding, so that shielding would be unnecessary in this unit; and the leads to and from the toroids are much shorter than would be the case with an enclosed trough with removable cover for tuning. It also serves (the cores) to make visible the small Erie 1.5-8.0 pF trimmer for easy tuning with a metal tipped plastic "tuning wand," plus the fact that the size of the miniature components reduces imbalance because of proximity to the chassis lid or front apron, from the inside.

By keeping the "field within the core," we save space, reduce radiation loss (high specific inductivity of 7.43), make the trimmers accessable for tuning without a cover removed, and have shorter leads to the tube. There are no fancy balance controls nor do you see half your power output drop off by removing lid of the Bud CU-482 convertabox! Perfectionists will find that increased balance for a sharper carrier null (more than 20 dB, as observed), can use a JAN type "place-over" shield base over the 6C9 tube socket; and with the unit operating DSB mode, move same eccentrically around-and-about the tube looking for decrease in output, on the reflectometer in forward position with maximum setting on level pot.

The last photo shows the underside of the unit, the neon NE-2's and the fullwave voltage charging electroylics and the output filter capacitor. The NE-2's were later replaced with higher current NE-83's for longer life (the 83's are pre-aged) and the same component protection. The purpose of the neon's is two fold: First, the highest dc voltage on the plates is limited to the top firing voltage drop of the two in series (about



220 volts) plus the drop through the 4.7 k 2 W resistor. Second, the operating point is established for the screen by having a voltage limit of only one neon drop at the lower end of the 20 k pot: this gives rather precise control of the modulated AM output in AB_2. Without the neon's, cathode bombardment may result from the excessively high plate and screen voltages when *not* transmitting or driving with some rf signal, but leaving the mode switch on DSB.

Use

We had trouble, at first, with the Two'er apparently going "spurious;" where the 72 MHz multiplier stage began leaking through the low-Q of the output tank; radiating a 1.5 microvolt signal around town on channel 5. Meck Brazelton, W4JSH, phoned me about it (since he is our local TVI expert), and we thought that this was an image on his new Amphenol Field Strength Meter. But it wasn't! The Two'er output was the cause (ceramic trimmer loosened-up). After this was corrected, we were much cleaner than a nearby Ameco TX-62; and had more 2 meter output.

Stability

The Two'er is crystal controlled and has an output frequency 18 times the fundamental of 8 MHz. Coincidental with the multiplier leak-through mentioned above, we had severe drifting (3 kHz in 10 MIN) which was cleared up with the new trimmer. Art, WB4ENO, helped check this with his new Interceptor receiver. There was some drift over a long period of time; but after a long warm-up this was minimized. We tried W4JKL's idea for "A Low Cost ac Regulator," described in January 1967 73, which improved things. With the Two'er, audio tubes must be removed to lighten the load,

*Available from Permacor, 9540 S. Tulley Ave., Oak Lawn, Ill.

and a 10 watt bulb worked better than 60. Incidently a similar series current regulator for a dual 30 watt draftsman fluorescent lamp has been in use here for 3 years, with no lamp replacements yet!

Using the KT-92 amp at the full five watts was not necessary. Only about 3 watts were needed to fully modulate 2 watts of rf. Negative peak degeneration allowed this to be; as it is possible in certain cases to use as much audio as rf, power-wise, if you use positive peaks of audio and dissipate maybe ½ watt in the zener impedance of 10 ohms: not overlooking the ½ watt audio dissipated on the screen, itself.

In designing the 6C9 balanced modulator, we chose the rf quiescent point to be fixed at about 2 volts negative (3.9 volt zener) average value; and the dynamic audio screen impedance was figured to be 15 K ohms, when viewed by the secondary winding, of a 10 K CT audio transformer at four watts. It takes a montrous amount of speech to make the unit flat-top; however, it will do this, even though theory says not! Not at least with screen-fed AM. The best way to set your amp level (and/or preamp) is to use an oscilloscope. Don't worry about DSB and AM being non-compatible! You can initiate QSO's on AM and then just flick a switch to go to DSB.

Traces

Using the 6C9 on-the-air has been a pleasure. Most local hams have not tuned DSB before, and several thought we were flat-topping AM or splattering, until it was explained that they should use their BFO. Oscilloscope traces were made of both screen modulated AM output and DSB, at the same setting of the KT-92 amp gain. It was interesting to see that regular AM had a zero reference line which could be interpolated by visual averaging, in the center; whereas DSB demodulated was like the speech waveform was "all positive or all negative" going; all good quality carrier-less random audio waves, because no carrier was injected in the demodulating probe used. To listen to it on a 'james dandy mixer, improved," was to hear the usual, muffled FM type sound on a Brush Clevite brand hi-z crystal earphone. There was a huge increase in level when switching to DSB, as theory would say = 8 dB.

For the engineers in our midst, I'd like to say that the method used here to create a DSB signal is pretty sound, we think, since the control grids of the 6C9 comprize most of the input capacity for the whole tube; neglecting Miller Effect, so that there is a small imbalance on these inphase electrodes, that very difference compared with the absolute value of the total input capacity is a very small percentage.

Conclusion

In this article we've seen the possibility of low-cost sideband for amateur use in the VHF bands, where it doesn't matter about which sideband is in use! This design can be adapted for 220-225 MHZ and maybe 432 MHZ with 787 Nuvistor tetrodes! There's really nothing to it, as they say, but start with equipment that doesn't cost too much . . . And start experimenting. If you can get "on," at all with home-brew, this unit should remove some of the hazy ideas you may have had about sideband on VHF. Note that the Two'er output is convenient for driving a varactor for extrapolated UHF design. Finally, the 51J4 set of listeners will have something new to tune, when you get on! . . . W4KAE

Getting Your Higher Class License

Part VI — More on Transmitters

Last month we observed that operation of a ham station involves three major items—a transmitter, an antenna, and a receiver.

In this section of the study course for the new Advanced Class license examinations, we're going to take up the second of three groups of questions dealing with transmitters.

The questions from the FCC study list which we'll be dealing with this month are as follows (the numbers are those assigned in the FCC study list, in case you're checking them off as we go):

19. When is an amplifier operating Class A? Class B? Class C?
20. What happens to even-order products in rf linear amplifiers?
23. How are bypass capacitors used How should their impedance compare to the elements they shunt?
24. How can TVI caused by cross-modulation be remedied?
27. What circuit factors affect the peak envelope power to a transmitter?

Since it's our aim to provide you more than just a list of answers to memorize, we'll follow our normal procedure of paraphrasing all these questions into broader, more general questions covering the same material. If you can answer the more general questions, you should have no trouble at all with the study-list questions—or with those on the actual exam.

The first question of this month's group deals with the classification of amplifiers. Let's rephrase it into the general inquiry, "How are amplifiers classified?".

The second deals with the action of even-order products in rf linear amplifiers. The more general view is, "What are 'products' in amplifiers, and what happens to them?"

The third deals with bypass capacitors and their impedance. Let's make it a little more general by asking, "How can signals on the same wire be separated?"

Number four asks specifically about TVI caused by cross-modulation. Let's generalize it by asking, "What is cross-modulation and how can it be prevented?"

Finally, instead of the detailed discussion of circuit factors affecting peak envelope power, let's find out "What determines the power output of a transmitter under any conditions?"

Ready? Let's go!

How Are Amplifiers Classified? Maybe this question should begin by asking, "What is an amplifier", because many different kinds of devices can amplify—and an amplifier is anything that amplifies.

Four our purposes, though, we can limit the definition of "amplifier" to "a circuit using either vacuum tubes or transistors which accepts as input an electrical signal, and produces as output a second electrical signal which is at every instant proportional to the input signal."

You might say that's not much of a limit, since the output signal can be either greater or less than the input signal—but some "amplifiers" produce voltage loss rather than gain, and a definition must be broad to encompass these too.

One way of classifying the things fenced in by this definition would be as "vacuum-tube" or "transistor" amplifiers, and you will frequently find these classifications used.

Another way would be by the kind of signals handled; this would include such classifications as "audio", "rf", "dc", "if", and "ac" amplifiers. This method of classification, also, is popular.

As it happens, though, a system of classification based upon the amplifier's operating conditions can cut across all other classification systems. This system, which parcels all amplifiers into either Class A, Class B, or Class C, has a unique advantage in that the A, B, or C classification tells you quite a bit about the amplifier's signal-handling characteristics.

If only one such system were in general

use we would have little to discuss here. Unfortunately, a number of systems—all differing in at least one detail from all the rest—use the same A, B, C classifications. If you have learned only one of these, you may find that you're not talking about the same thing as the other guy even though you're using the same words.

For instance, a Class A amplifier is sometimes defined as an amplifier in which current flow in the output circuit remains constant during the operating cycle. This definition cannot be correct—if current flow remained constant at all times, no signal could be developed! If this definition is modified to read "average current flow", then it's okay.

But other authorities define a Class A amplifier as one in which current in the output circuit is never cut off during the operating cycle.

This definition, too, is okay—but it isn't consistent with the first. That's natural, since we're dealing with two different classifications systems that just happen to use the same names.

Still another definition frequently used for a Class A amplifier is "one in which gain remains constant"; a fourth requires that the amplifier be distortion-free.

Before we get completely confused, let's turn and look at definitions for Class B. The system which defines Class A operation as "constant average current" defines Class B as "average current varrying". That which calls Class A "current never cut off" class Class B "current cut off for less than half the operating cycle". That which calls Class A "constant gain" calls Class B "varying gain", and that which calls Class A "distortion-free" calls Class B "low-distortion".

How about Class C? In order, it may be defined as "extreme current variation", "cutoff for more than half the cycle", "all-or-none gain", or "highly distorted".

With all these different sets of definitions running around, how are we ever going to come up with an answer which we can consider to be the *the* right answer—or can we?

The answer is yes, we can, because all of these various systems of classification are attempting to describe the same general concepts, and the apparent differences are more in the words chosen to describe the concepts than in the concepts themselves.

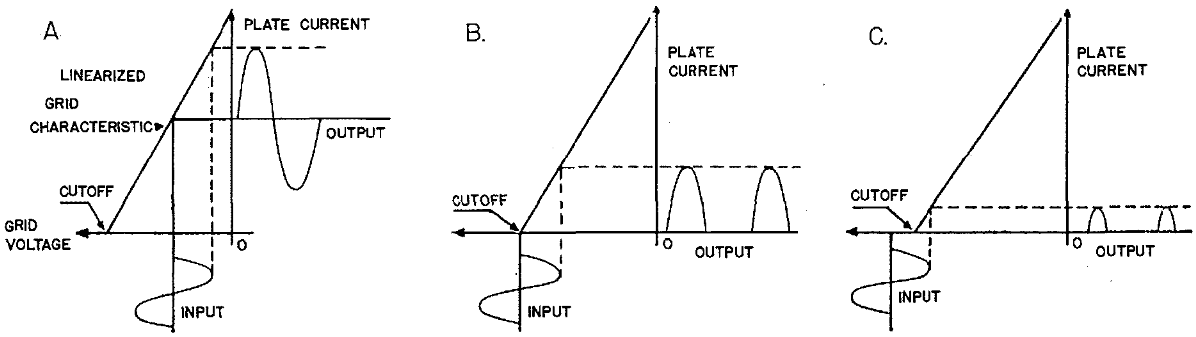
Before we get into our attempt to bridge this particular communications gap—and it *is* a major gap—let's take note of a couple of facts. All of the four systems we've sketched out use the A, B, or C letters to indicate "pure" cases, and in practice most amplifiers fall somewhere in between. This is particularly true of the boundaries between class A and Class B, and as a result most amplifiers we meet in real life are known as Class AB amplifiers. These are a little of both, and so are exclusively neither!

The concept of a Class A amplifier is that of an "ideal" amplifier in which any input signal is faithfully reproduced at the output, without distortion. In a perfect amplifier, this normally would require that current keep flowing throughout the entire operating cycle (since all devices are imperfect at the extreme limits of their operating ranges, and to be perfect we would have to avoid the imperfect regions), and that the average current flow be constant (if the input signal is symmetrical). Gain would also be constant. Thus all the definitions merge into one—for a perfect amplifier.

The concept of Class B operation is again based upon a perfect circuit, in which non-linearity would be impossible. If the current is biassed precisely to the point at which output-circuit flow ceases, then any positive-going input signal would permit current flow in the output circuit. Since we defined the circuit as "perfect" and without any non-linearities, as soon as current flow is permitted the amplifier is producing its normal gain. This in turn makes the output signal a replica of the input signal—but only for the half-cycle of input signal which permits current flow.

Current flow in this arrangement is for exactly one-half of the operating cycle. As a result, average current flow would fluctuate with the signal level—stronger signals would draw more current, on average, than weaker ones. Gain would vary from zero when the amplifier is cut off to normal when it is turned on. And distortion would be 50%; none when the amplifier was on, but total when it was cut off.

In practice, of course, it's almost impossible to keep the bias at the exact point to permit current flow for precisely one-half cycle. Even were it easy, tubes and transistors have such high distortion at low current that proper operation would be difficult. For this reason, in "Class B" designs



Class A—Output is replica of input current flows throughout cycle

Class B—Output is only half of input current flows for only half cycle

Class C—Output is like input only in timing current flows for less than ½ cycle

Fig. 1—Transfer curves (with idealized transfer characteristic) illustrate differences between Classes A, B, and C. Actual amplifiers never have sharp break at cutoff, so ideal operation shown here can never be realized. Practical amplifiers do come close to this, however. For illustration, all input signals are same amplitude. Class C circuits are normally overdriven to achieve full efficiency.

bias is set so that current flows for more than half a cycle, but less than a full cycle. In some designs it always flows, but varies widely over a cycle; both these variations are, technically, Class AB operation.

Finally we have the concept of Class C operation. One authority has described this, very accurately, as "switching" operation. The tube or transistor is completely cut off most of the time, and is "switched" on by the most positive peaks of the input signal. When "on", it acts like a closed switch and conducts as heavily as it can. The output is a series of current pulses, each corresponding with the tip of an input signal.

Current flow in this circuit is appreciably less than half an operating cycle, and is either all or nothing at all. Gain, similarly, is "infinite" when the amplifier is "on", and zero when it is "off". Distortion is almost total; those input signals which are strong enough to turn it "on" turn it all the way "on", and those which aren't, leave it "off".

You may notice that in the description of these three concepts we haven't mentioned "grid current", although quite a few persons tend to believe that the flow of grid current is connected directly with the A, B, or C classifications of an amplifier. They use the condition of "no grid current" to define "Class A", and "grid current" to define "Class C", then defining "Class B" as the region between A and C.

However, it is quite possible to design a Class A amplifier in which grid current is permitted to flow, and quite a few Class C circuits without grid current have been built since the high-perveance TV horizontal-output tubes became popular. Presence or absence of grid current is normally indicated by a subscript on the classification, such as AB_1 or C_2; the "1" indicates no grid current, while "2" shows that grid current flows.

In actual fact, though, the grid-current condition has nothing to do with the operating classification. Class A amplifiers may be A_1 or A_2, and Class C circuits may be either C_1 or C_2. The effective classification criterion is the duration of current flow in the output circuit.

Class A amplifiers are used almost exclusively when low-distortion amplification is needed, as in audio circuits or low-level SSB generation. Most receiver circuits are Class A.

Class AB or B amplifiers are widely used to deliver moderate amounts of power, with limited distortion. The audio output stages of many PA amplifiers and almost all hi-fi installations operate in Class AB. Similarly, almost all SSB final linears are either AB or B. In audio, use of class AB or B requires a balanced (push-pull) circuit in order to cancel out the inherent distortion. When rf is being amplified, distortion of individual cycles is not important so long

as the *envelope* of the signal is faithfully reproduced. A properly adjusted amplifier will do this, and so an unbalanced circuit may be used.

Class C amplifiers are limited to rf power amplification in which envelope distortion is not important. This, in turn, prohibits their use for SSB or AM amplifiers, although if high-level modulation is employed all the rf stages of an AM transmitter may operate Class C since modulation is applied only at the output of the final stage. The major advantage of the Class C amplifier is its relative efficiency; Class A amplifiers normally produce about 1 watt out for every 4 watts dc input. Class B circuits may produce as much as 2 watts out for the same 4 watts dc input, but Class C circuits usually produce at least 3 watts and sometimes even more for every 4 watts in.

What Are "Products" in Amplifiers, and What Happens to Them? The word "Product" has become a "magic word" in ham radio. We have "product detectors" and "distortion products", as well as many others. But what are these "products" we keep talking about?

In an earlier instalment of this series we noted that application of two signals to any non-linear element resulted in the production of, not only the original signals, but new signals made up of the sum and difference frequencies of the originals. This "mixing" action is the basis of all kinds of modulation, as well as of the superhet receiver and all common SSB generators.

A "product" is any output signal from such a mixing action. The original signals are "first-order" products, since each represents "one" times itself plus or minus "zero" times the other. The coefficients "one" and "zero" by which the input signals are multiplied produce a sum or difference of "one" whether they are added or subtracted, and this sum or difference represents the "order" of the product.

Similarly, the output signal representing the sum of the two original frequencies is a "second-order" product, since it is "one" times signal F1, plus "one" times signal F2, and one and one make two. The difference signal, on the other hand, is a "zero-order" product, since one minus one is zero.

Keep in mind that the same non-linear element which permits mixing of two input signals also permits just *one* signal to mix with itself to produce a second-order product which is the second harmonic of the single input signal. This second-order product can then mix with the original signal to produce a third-order product (the third

What this means, then, is that in *any* mixing circuit you will never have just two frequencies with which to deal. In addition to the two frequencies you put in yourself, you have many harmonics of each which are generated by mixing action inside the circuit.

Each of these harmonics can mix with each and every other signal present in the circuit, to produce a near-infinite number of "products".

This is *not* just a hypothetical fiction; it actually happens in all non-linear circuits—and virtually all circuits are non-linear to at least some degree.

In a "linear" amplifier we take great pains to reduce the mixing action—in this case we call it "intermodulation"—to the smallest possible degree, but we can never eliminate it completely.

Since it cannot be eliminated, the output could be expected to contain at least small portions of all the possible products from any pair of frequencies present in the input at any time.

In practice, though, only the odd-order products can be found. The even-order products appear to vanish. Why?

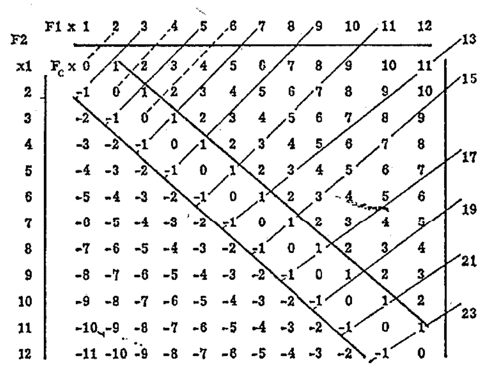


Fig. 2—Difference products for first 12 harmonics of two tones are shown here. Those products near the original frequency (indicated by 1 and "−1" in the table) cannot be rejected by output tank circuit and so appear in amplifier output. All other products disappear in the output circuit, but may still act as additional tones to create new families of products.

harmonic), and this process can continue in an infinite loop so long as the new harmonics which are generated by each step are strong enough to be detected.

Fig. 2 shows the reason. In this chart, we're not interested in exact frequencies. We are, however, interested in the *order* of the products produced by two close but not identical frequencies such as those typically present in a voice sideband. We call these two frequencies F1 and F2. In **Fig. 2,** each column represents the products of *one* harmonic of F1, from the first (fundamental) to the 12th, and each row represents the products of one harmonic of F2 over the same range. The column-row intersections contain the number which results when we subtract the harmonic order of F2 from that of F1. As we have already seen, this number (ignoring its sign) represents the order of the corresponding product.

For example, the product formed by the 6th harmonic of F1 and the 4th harmonic of F2, as shown on **Fig. 2,** is of order 2. The "sum" products formed by F1+F2 are not shown.

The diagonal lines in **Fig. 2** represent the selectivity of the output circuit of our amplifier. This tuned circuit can pass most frequencies which are approximately the same as those of F1 and F2, but rejects frequencies which are as much as twice F1 or F2, or as low as half.

Note that all the even-order products are either 0, 2, 4, or higher even numbers. None of these products fall within the passband of the output circuit.

The odd-order products, however, all include at least two products which are of approximately the same frequency as the original signals, and so get through the output circuits. The 5th-order product of either 3xF1-2xF2 or 2xF1 - 3xF2 has an order of 1. The highest-order products shown in this illustration are the 23rd order, and two of these still fall within the passband.

Fig. 3 shows this in more detail for the first nine orders of products. In this chart, all differences greater than the nominal original frequency (FO) are omitted. You can see readily that the even-order harmonics fail to fall within the passband, but all the odd-order groupings have two separate difference frequencies which do come inside the limits and get out to cause trouble.

ORDER	COMPONENTS	DIFFERENCE
2	F1, F2	DC
3	F1, 2F2	FO
	2F1, F2	FO
4	2F1, 2F2	DC
5	2F1, 3F2	FO
	3F1, 2F2	FO
6	3F1, 3F2	DC
7	3F1, 4F2	FO
	4F1, 3F2	FO
8	4F1, 4F2	DC
9	4F1, 5F2	FO
	5F1, 4F2	FO

Fig. 3—This table shows only the difference products near the input frequencies and near DC level for the first 5 harmonics of two input tones, and illustrates how the product "order" is identified.

It's especially important to realize that these distortion products cannot be filtered, since they survive in the first place only because they are in the same frequency range as the desired signals. The only way to minimize them is to adjust and operate the amplifier circuit in such a manner as to make it as linear as possible. In such a case, mixing action will be small compared to the amplification, and the unwanted products will be much weaker then the desired signal. Ratios of as much as 50 db between distortion and signal are not uncommon—but overload of the amplifier in an effort to get another watt out to the antenna can make the distortion as strong as the signal.

How Can Signals On The Same Wire Be Separated? Within almost any of our amplifier circuits, we have both dc power for the circuit and ac signal being processed by the circuit present on the same wires. Outside the limits of the circuit, however, we want to keep the ac and dc signals separate. That's the meaning of this question—how can we do it?

The secret of accomplishing this feat of signal separation lies in the fact that ac can be transferred through certain circuit elements which block dc, while dc can go through others which tend to block ac from passing.

For instance, ac will flow through a capacitor while dc will not; on the other hand, dc flows through an inductor while ac is impeded. This is the whole basis of filtering.

Any practical circuit element, of course, has resistance, inductance, and capacitance, all at the same time. This is true even for such a simple element as an inch-long

piece of hookup wire! For a length of straight wire all three are very small values—but they are not always negligible. The inductance present in a fraction of an inch of wire, for instance, can be used to tune a bypass capacitor to form a series-resonant circuit, and thus increase its bypassing efficiency.

To separate an ac signal from a dc signal or power flow on the same wire, then, we must separate the wire to form two paths and then place capacitance in one path to limit it to ac flow while placing inductance in the other path to restrict it for dc only.

We frequently use this principle in untuned rf amplifiers, where an rf choke provides the inductance and a coupling capacitor provides the ac path for the output signal.

When we're dealing with an amplifier circuit, both the ac and the dc output-circuit paths must be complete, from amplifier-tube cathode (or emitter) through the tube or transistor to the plate (or collector), and back to the cathode. The desired output signal is coupled to the next stage by either capacitance or inductive (transformer) coupling in most cases, but this doesn't completely satisfy the requirement for a complete path. Some parts of the circuit, for example, must be at ground potential for ac voltages while remaining at high potential for dc—one example is the screen grid of a tetrode or pentode.

The function of a bypass capacitor is to complete such an ac current path by routing the ac directly to ground, yet keeping the dc voltage isolated. Another function for which bypass capacitors are frequently used is that of maintaining ac ground points throughout the power-supply wiring of a unit, in order to prevent undesired coupling between successive stages. And still another function of some bypass capacitors is that of assuring that all rf circuits contain minimum-length current paths, to prevent "ground loops" which can cause undesired coupling between portions of the same circuit.

In order to perform all these functions, the bypass capacitor must appear to be a very low impedance for the particular ac current expected. However, any specific value of capacitance which might be a "very low" impedance for current of one frequency might be a very high impedance for current of much lower frequency.

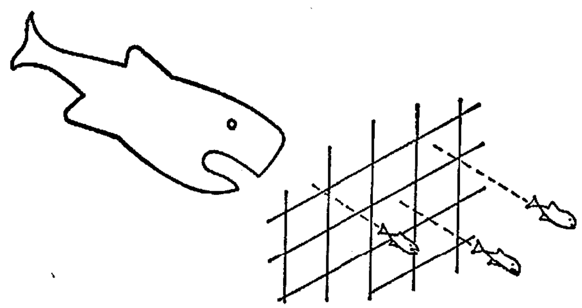


Fig. 4—The problem of separating two signals on one wire is very much like that met by fish-breeders who need to keep the little fish away from the hungry big ones in the same tank. Fish-breeders use a mesh "filter" which the little ones can get through but the big ones cannot. We use impedances to filter signals in much the same manner.

And even if the rated capacitance value represents a low impedance, the physical construction of the capacitor might be such that non-rated inductance could reduce (or even cancel out) its actual capacitance within the circuit.

This is the reason that flat or disc ceramic capacitors are so frequently favored for rf bypass use; their construction minimizes inductance. For most rf applications; capacitance values from 0.01 to 0.001 μf are suitable. In critical positions, capacitance values should be calculated—and this requires a knowledge of the dc impedances to be expected in the circuit.

The rule of thumb most often used when calculating the required value of a bypass capacitor's is that the capacitor's impedance should be at least 10 times less than the impedance of the rest of the circuit.

That is, for instance, in a screen-grid circuit supplied its dc through a 1000-ohm resistor, the bypass capacitor's impedance could be any value up to 100 ohms.

This rule is based upon the fact that in a network containing parallel impedances, current flow through each is determined by the ratio of each impedance to the others. The most current will flow through the smallest impedance. If one is at least 10 times less than any other, that one will carry at least 90 percent of the current.

The figure "10" is not sacred in this rule, but represents the experience of some 40 years of engineers. The ratio certainly should not be less than 10-to-1; an even greater ratio offers better bypassing, up to the point at which a capacitor which is so

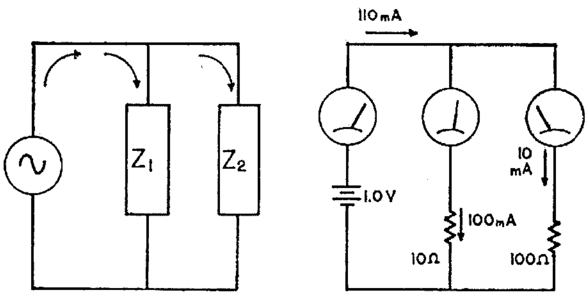


Fig. 5—Principle upon which bypass capacitors work is shown here with generalized impedances (top) and with resistors (bottom). If 10-ohm and 100-ohm resistors are connected in parallel, 10 times as much current flows through the smaller resistor. Similarly, if a low impedance is in parallel with a high one, the low impedance takes most of the current. Bypasses are deliberately-introduced very-low impedances, to "bypass" most of the current away from the rest of the circuit (represented by the higher impedance).

large physically that it begins to lose its effectiveness becomes required.

The filtering or "decoupling" uses of bypass capacitors are not limited to power circuits. They are also widely used in CW keying circuits, for instance, and also (by proper and somewhat critical choice of capacitor values) to bypass rf from audio signal lines and prevent rf feedback into modulators. In every case, the bypass capacitor should offer an impedance to the signal being bypassed which is much lower than that of the element which the capacitor shunts.

What Is Cross-Modulation and How Can It Be Prevented? The term "cross-modulation" is most often heard with reference to TVI, unless you happen to be a VHF addict. In the VHF world, it more often is used with regard to creation of spurious signals in the front ends of sensitive receivers.

No matter which context the term conveys to you, "cross-modulation" is nothing more complicated than our old friend, the mixing action which results when two signals reach a non-linear circuit element.

When the mixing is intentional, as in a superhet receiver, a SSB generator, or a detector, we're happy and then we call it by its proper name, "mixing".

When it's unintentional—as in a distortion-producing amplifier, a case of TVI, or a blocked VHF receiver—we use such names as "intermodulation", "distortion products", and "cross-modulation", as well as many others which won't bear repeating in a publication circulated through the U.S. mails!

But whether intentional or unintentional, the process remains the same. Two signals applied to a non-linear circuit element produce not only the original signals, but a whole host of products as well.

If mixing is intentional, it's usually done within a circuit designed for that purpose—but there's no physical law which requires that the non-linear element be a part of any designed circuit. For instance, a corroded gutterpipe or a leaky insulator on a power-pole guywire may form a sort of happenstance electrolytic capacitor or chemical rectifier, and there's nothing much less linear than a device which changes ac to dc.

That's one of the major causes of "cross-modulation". Two relatively strong signals reach some completely unexpected (and frequently impossible-to-locate) object which happens to be, in addition to its intended use, a non-linear element. There they mix, and all the products are radiated back into space along with the original signals. In the case of TVI, one of the signals may be your own transmitter and the other may be any other transmitter. Neither need be

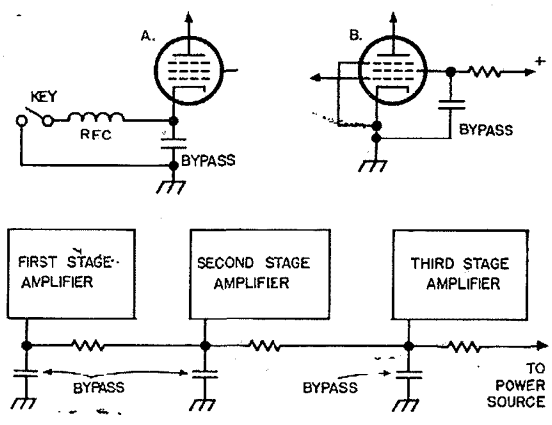


Fig. 6—Several typical applications of bypass capacitors for separation of ac and dc signals are shown here. At A, the long leads necessary to reach the key contacts in a cathode-keyed CW transmitter are isolated from the rf circuit by a choke, and the rf circuit completed by the bypass. At B, the bypass acts to keep the screen grid at the same rf voltage as the cathode by providing an ac short-circuit, while leaving dc voltage at its normal higher potential. At C, bypasses at each stage decouple the various stages by keeping ac signals off of the common power-supply leads.

	F_1	$2F_1$	$3F_1$	$4F_1$	$5F_1$
F_2	F_1+F_2	$2F_1+F_2$	$3F_1+F_2$	$4F_1+F_2$	$5F_1+F_2$
	F_1-F_2	$2F_1-F_2$	$3F_1-F_2$	$4F_1-F_2$	$5F_1-F_2$
$2F_2$	F_1+2F_2	$2F_1+2F_2$	$3F_1+2F_2$	$4F_1+2F_2$	$5F_1+2F_2$
	F_1-2F_2	$2F_1-2F_2$	$3F_1-2F_2$	$4F_1-2F_2$	$5F_1-2F_2$
$3F_2$	F_1+3F_2	$2F_1+3F_2$	$3F_1+3F_2$	$4F_1+3F_2$	$5F_1+3F_2$
	F_1-3F_2	$2F_1-3F_2$	$3F_1-3F_2$	$4F_1-3F_2$	$5F_1-3F_2$
$4F_2$	F_1+4F_2	$2F_1+4F_2$	$3F_1+4F_2$	$4F_1+4F_2$	$5F_1+4F_2$
	F_1-4F_2	$3F_1-4F_2$	$3F_1-4F_2$	$4F_1-4F_2$	$5F_1-4F_2$
$5F_2$	F_1+5F_2	$2F_1+5F_2$	$3F_1+5F_2$	$4F_1+5F_2$	$5F_1+5F_2$
	F_1-5F_2	$2F_1-5F_2$	$3F_1-5F_2$	$4F_1-5F_2$	$5F_1-5F_2$

1. $F_{1M} = MF_1$
2. $F_{2N} = NF_2$
3. $P_{MN} = F_{1M} \pm F_{2N}$
4. RANGE OF M AND N IS FROM 1 TO INFINITY; PRACTICAL RANGE IS FROM 1 TO 10.

Fig. 7—This table shows the formation of mixing products by two input frequencies F_1 and F_2 and the first 5 harmonics of each. Note that 50 separate products are formed here alone, 25 by the sums and 25 by the differences, although not all of these products are of different frequencies. The equations numbered 1, 2, and 3 define the table for all harmonics; m and n in these equations indicate the harmonics, while P_{mn} is the product pair for any specific harmonics. Whenever P_{mn} has the same frequency as some transmission of interest to someone else, that transmission suffers cross-modulation interference.

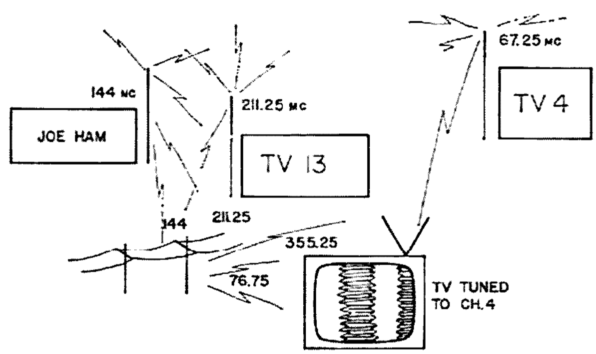


Fig. 8—How cross-modulation causes interference. Joe Ham, operating a completely clean transmitter at 144.0 MHz, and TV Channel 13, also completely clean at 211.25 MHz (video carrier frequency) are on the air at the same time. Somewhere in the neighborhood, a corroded connection on a power-pole guy wire is acting as a non-linear element. Meanwhile, a TV viewer is trying to watch Channel 4 at 67.25 MHz, The 144 and 211.25 MHz signals mix to produce products all over the rf spectrum (only a few are shown). One of these is at 67.25 and interferes with the Channel 4 signal. If, however, Joe moves his frequency up ot 144.1, the interfering product will move down to 67.15 MHz and may no longer cause trouble.

operating at anywhere near the frequency of the TV channel—the only requirement is that one of the products of the mixing come out on or near the TV station's frequency, and presto, instant TVI.

This form of TVI is quite difficult to isolate because it will go away whenever either of the two original signals goes off the air. You don't have to do a thing. If the other transmitter goes dead, the TVI ceases.

If the interferring product is formed by your fundamental, any modulation on your signal will be present on the product as well, making it quite easy for the TV viewer to obtain your call and work from there to lodge his complaints.

And the biggest problem about it is that you can do almost nothing to cure it. No malfunction of your transmitter is involved. No filtering, either at the transmitter or at the TV receiver, can stop it, since the interference is an actual radiated signal at the frequency of the desired channel and any filter which would remove it would remove the TV station as well.

The one sure cure is to change your operating frequency enough to move the offending product away from any TV channels. This doesn't actually cure the mixing, but it eliminates any interference to TV reception. Often a change of only a few kilocycles is adequate.

When cross-modulation is interfering with your own operation the picture is different. A classic case of this type of cross-modulation can be observed by any 2-meter operator who lives in an area served by television channels 4 and 13. The frequency separation between these two channels is exactly 144 MHz. When both stations are broadcasting, the DX portion of the band, from the bottom edge up to at least 144.05 MHz, becomes a howling mass of cross-modulated video, FM audio, and carriers.

The only cure for this problem is to avoid that part of the band, which is rather difficult if the stations you want to work stay there most of the time. Unlike ham stations, TV broadcasters are not free to change frequencies.

A cure which is sometimes effective is to locate and eliminate the offending nonlinear element. If you're lucky you may find it within a month or two—but keep in mind that a 1-watt signal can be heard for many miles. The re-radiated products are considerably weaker than one watt, but the cause of the crossmodulation may be anywhere within a two-to-three mile

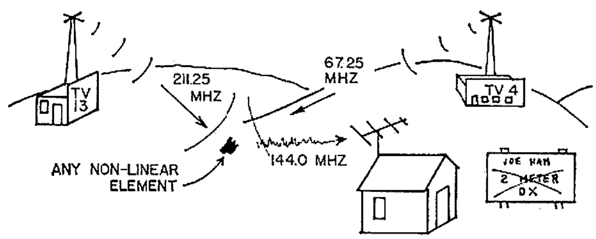


Fig. 9—It's not just the TV audience who get hurt by the problem of cross-modulation. Any two signals can do it, and one of the prime examples is that occurring when TV channels 4 and 13 operate in the same locality. 2-meter DX around 144.0 MHz is completely wiped out by the interference which results. Since any type of non-linear element can cause the mixing action, it's not normally practical to eliminate this problem; most of us just learn to live with it.

radius of your location. One such cause is all it takes, but there may be many. The odds are against you.

Cross-modulation is not limited to the "natural cause" case. It can also occur in the front end of your receiver, and frequently does. This type of cross-modulation can be cured readily by filtering out the offending signal. If the unwanted strong signals are too close to your desired signal (which is possible if you are getting a third-order product) for this to be practical, you may have to introduce an attenuator between antenna and receiver to cut back all signal strengths to the point that no overloading and resulting cross-modulation occurs. This cure is frequently used.

What Determines the Power Output of a Transmitter? Some amateur transmitters boast a power output of more than 2000 watts, legally. Others find favor with do-it-the-hard-way enthusiasts and radiate only a few milliwatts or even microwatts. Each type, as well as the wide spectrum between these limits, has its place.

But what determines the power output? No single answer to this question is possible, because power output is determined by many things. One of the most important factors is that of *what* power output we're talking about, since transmitters are rated by such various standards as average input power, average output power, peak input power, peak output power, peak envelope power (both input and output), and even indicated average input power!

Any attempt to compare various methods of transmission almost invariably comes a cropper over these differing types of rating power, and the FCC regulations themselves have a sort of built-in discrimination—which is, of all things, in favor of voice transmission and against CW!

The regulations, you see, limit the indicated input power to the stage or stages of the transmitter which supply rf power to the antenna. On the face of it this appears to be consistent for all modes of transmission.

Yet with FM, the indicated input power and the peak envelope input power are identical. The same is true with CW. High-level AM indicates only the carrier power; the additional power present in the sidebands which contributes to peak envelope power is not indicated. This means that with AM, a PEP input of 1500 watts is permitted if audio power is included. When SSB or DSB, with suppressed carrier, are employed, the indicators swing at a syllabic rate. In this case, the regulations state that the 1000-watt limit must never be exceeded by the indicators. They do recognize that the indicators cannot keep up with instantaneous peak levels, by specifying response times for the indicators of ¼ second maximum. This means that with SSB or DSB, PEP inputs of 2000 to 2500 watts are permissible just so long as the meters never read more than 1000 watts.

The same flickering effect is present when CW is transmitted, but the CW operator is denied the privilege of taking advantage of it. He must make his power measurements with key down; if he sets up for 1000 watts in this condition, his indicators won't exceed 750 watts in most cases. If he has a particularly choppy first, they may not exceed 600 watts.

In all these cases, "indicated average input power" is 1000 watts. The peak envelope powers, though, vary from 1000 watts up through something over 2000 watts depending upon the type of transmissions being generated. Transmission type, then, must be one of the factors determining peak envelope power's relation to indicated average input power.

It does not, however, affect the peak-power capability of an amplifier. The peak-power capabilities are determined by the characteristics of the tubes or transistors employed in the final stage or stages, by the supply voltage and the amount of cur-

rent available rapidly (size of capacitors in power supply filter), and by the other design characteristics of the amplifier circuit.

Characteristics of the tubes or transistors in the final stage which determine a transmitter's peak-power capabilities are (1) the maximum current-handling ability of the cathode or emitter and (2) the permissable power dissipation or the plate or collector.

The maximum current-handling ability is not directly related to the rated maximum current. A cathode surface may be able to handle a full ampere for a sufficently brief period of time, yet be rated for only 50 to 100 mA maximum current. This comes about because the *rated* maximum current is a dc value and the tube is supposedly able to handle this amount of current for any period of time. The absolute maximum though, is set by point at which the cathode begins to physically disintegrate and is far greater. Tubes such as the 6C4, for instance, can deliver peak powers in the kilowatt range when operated under pulse conditions with sufficiently long time allowed for recovery between the extremely brief periods of active operation—but are hard put to deliver more than a watt or so in continuous operation.

The influence of the maximum current-handling ability is to set an upper limit on peak power. The tube cannot handle more current than it can; when you have all it can handle, you can't have any more.

The permissible power-dissipation for the tube determines peak-power capability by limiting the amount of *heat* which can be tolerated. This, in turn, is influenced by the type of amplifier involved. A Class A amplifier may turn ¾ of its dc input power into heat, while a Class C amplifier (using the same tube) might make heat from only ⅕ of its input.

Thus a tube capable of dissipating 10 watts would be able to run at an average power input of only 13⅓ watts if operated Class A; 3⅓ watts power output would be produced, and the remaining 10 watts would be dissipated by the tube. The same tube, in Class C, could run at an average power input of 50 watts. Of these 50 watts, 40 would appear as output and the other 10 would heat up the transmitter.

Note that the power-dissipation limit applies to *average* power, not to peak. Heating and cooling take time, and anything that requires an appreciable period of time must involve only the *average* values over that period of time.

Note also that the effect of the power-dissipation factor is strongly dependent upon the operating conditions chosen for the amplifier—and these are included in those "other" design factors for the amplifier circuit.

The supply voltage and the amount of current rapidly available determine power capabilities, because power is simply the result of multiplying voltage times current. Voltage can be stepped up or down by means of transformers, but in any practical transmitter the voltage applied to the final amplifier stage at any instant rarely exceeds twice the voltage of the power supply, so this supply voltage is still a major factor.

Rapid availability of current is a factor not so widely recognized. In a power supply, though, whenever any current is taken out to produce rf power to be transmitted, that

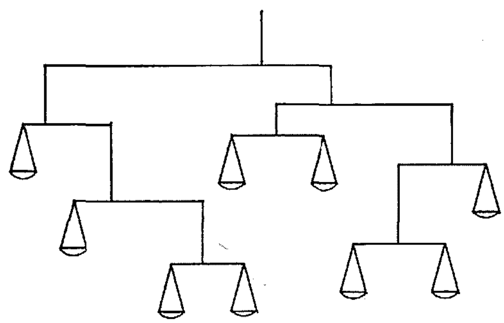


Fig. 10—Circuit factors affecting transmitter power are somewhat like the complicated set of scales shown here. Any change in any one factor will affect the balance of all other factors as well, but almost any combination of the various factors can be made to balance out with sufficient care.

current must be restored through the rectifiers. The current taken out on an instantaneous power *peak* may be much greater than that which the rectifiers can supply, if there will be enough time before the next peak (while less current is being taken out) to make up the difference. The current ratings of the rectifiers, then, are not nearly so critical in determining transmitter power limits as is the amount of current *storage* within the supply. This means that filter capacitors on the output side of the supply should be as large in value as possible. It's difficult to have too much.

Some of the other design factors which influence power capability include the choice to operate Class A, B, or C, discussed

earlier; the type of coupling from amplifier tube to antenna and particularly the impedance level at which this coupling operates; and to a lesser degree the type of modulation employed.

With a given amount of dc voltage supplied and a given amount of current available, the power developed is determined directly by the load impedance across which the output signal is developed. The "Q" of the final tank circuit gets into the act since it determines the load impedance "seen" by the tube. For any useful power to be produced, the Q must be relatively low. A high-Q circuit may permit as much power to be developed at the tube as does a low-Q one, but the power cannot get out of the circuit if Q is high (by the definition of Q as the ratio of power stored during a cycle to power released during a cycle) and thus is of no use to you. At the same time, Q must be moderately high or the output circuit won't provide the desired tuning action. Choice of Q is always a compromise; the choice is normally made by the "loading" control of the transmitter. When loading is light, the Q is high; when loading is increased, the Q decreases.

Type of modulation to be used affects power in a number of subtle ways. Some of them were mentioned in the discussion of the various legal power limits. The "on-off" effect brought out there for SSB, DSB, and CW signals permits the factor of power dissipation to be modified by intelligent choice. For example, SSB and DSB signals have a very low *average* power in comparison to their peak-envelope-power levels. For this reason, when only such signals are to be transmitted tubes with very low power-dissipation ratings but very high peak-current capabilities may be chosen, and relatively great amounts of output power be developed. This is the reasoning behind the popularity of TV-output tubes as final amplifiers in the 100-400 watt range. The voltage and peak-current ratings of these tubes permit peak powers of 400 watts or more; power dissipation is low, but in DSB or SSB service the average power to be dissipated is also low and this factor becomes only a small restriction.

For FM service, or for CW, such tubes are pushing their limits at 100 watts or so. The only way in which even these power levels can be realized is to use the most efficient points available in Class C operation, to keep power dissipation within limits. Even so, it's not uncommon to literally melt down parts of the glass envelopes of such tubes in this application!

Next Month. One of the most important practical aspects of radio theory, though, is the making of measurements. Without measurements, you cannot operate. The importance of measurements can be judged by the fact that most of the FCC regulations require measurements of some type—and a major part of the examination deals with measurement techniques. That's our subject next time. ■

License Plate Holder

One of the nicest little low cost items to turn up recently is a license plate holder which is being marketed by Ken Walkey WB6RSP. Most of the call letter license plates are the standard 6" x 12" and they really stand out when mounted in the Walkey holders. Across the bottom in blue letters on white background it tells the world that you are a radio amateur. The holders are triple chromium plated so they will not rust. They are $3.95 a pair from Ken Walkey, Box 3446, Granada Hills, California 91344.

Help Wanted

Amateurs looking for a change of job would do well to run an ad in our classified section. A 25 word ad is only $2 plus $1 extra for a box number if you wish to remain annonymous. Almost one third of our readers are in a position to either hire men or influence the hiring of men. And you know that all of the ham manuafacturers are reading the magazine.

There is an impossible demand for good technicians and engineers now. Try 73 and see what happens.

Employers could do a lot worse than to run help wanted ads in 73. A ham will usually be a better engineer or technician than a straight school man . . . it is the difference between it just being a job and being a dedication. Commercial ads in the classified are $10 for 25 words plus the dollar for a box service if confidential replies are wanted.

In my talking with ham manufacturers I am constantly being asked if I know where they can find good men. The need is great. Are you working below your level of earnings and opportunity?

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Care and Feeding of a Ham Club—III

Carole Allen W5NQQ
308 Karen Drive
Lafayette, La. 70501

How About A Party?

Who needs help with a party, you ask? Sure, anybody can have one, but it takes planning if everyone is going to have fun, be it a ball, banquet, or barbecue.

The social side of radio clubbing means anything from coffee and cake after the business session to a full scale affair at a ritzy restaurant. Most hams like food, and there's no doubt that a bubbling percolator and sack of doughnuts adds to any evening. But these magic ingredients just don't appear out of the air—a committee will have to see that they do.

If meetings are held in members' homes, kitchens are handy, and many public meeting places also have facilities; however, yours may be a club that has to buy a hotplate or carry in goodies. Stag clubs are sometimes lucky enough to have Ladies' Auxiliaries who function with the purpose of planning refreshments for the fellows. A very satisfactory arrangement for many groups is taking turn-about at providing snacks. To prevent a last minute discovery that nobody is bringing the sugar bowl, it's a good idea to plan a social calendar in advance. If hosts and hostesses volunteer for meetings early in the year, a sheet can be printed and distributed showing who's going to serve and at what meeting.

In addition to regular get-togethers, most clubs sprinkle the year with picnics, barbecues, dances, card parties, and formal banquets. These events, and especially the last one, demand lots more work. Your choice of clambake will depend on your locale; for instance, the Pensacola (Florida) Amateur Radio Club gets a bang out of shrimp boils and fish fries, but a barbecue would probably be first choice in Southern California and a pot-luck buffet in Indiana.

Some wise soul once said that variety is the spice of life, and hams around the country prove it. The secret is not to be afraid to try anything once; if the card party is a flop, you won't repeat it; likewise, the party plan you had doubts about may really make a hit with the gang.

Hams like to laugh, and a party program is more successful with a few jokes. Bill, K9AKF, receives a mobile antenna complete with oil can and other awards from Program Chairman K9AMD.

Since all types of shin-digs require similar ground-work, let's see how one comparatively small group plans a whale of an annual spring whing-ding. The sponsoring club consists of about thirty active members and twenty not so active. Regular meetings are held monthly with both OMs and XYLs attending. Every April, members and their families hold a "Ham Scramble" at a com-

munity center where there is plenty of room and also kitchen facilities. Although the event is not designed on hamfest proportions, area hams are invited.

The Ham Scramble is held on Sunday and kicks off about 3 p.m. The afternoon is spent ragchewing and working on contests and paper games planned by special committees. QSL cards are displayed as well as surplus gear hauled in for swapping. Everybody mills around contentedly talking and "contesting" while the ladies prepare food and set tables. Each family brings its own table service and covered dishes for "scrambling." Coffee for hams and milk for harmonics is furnished.

"Chow time" is called about 5:30, and no one has to tell a ham what the word 'smorgasbord" means. A program following the meal begins with group singing and continues on the same informal note including the awarding of both serious and humorous prizes. This is a good time to award 100% attendance plaques or pins to deserving members as well as a "booby-type" prize to a ham who can take a joke. Ideas that have audiences rolling in the aisles include presenting a can of cleanser to someone who needs to clean up TVI, a megaphone for the fellow who has transmitter trouble or says he can't "get out," an ax or hatchet to cut QRM, a make-shift trophy for a new General Class operator, and other rib-tickling awards for hams who enjoy a good laugh.

The main event of the evening is planned to interest unlicensed wives and children also. An after-dinner speaker with stories for the kids, a colorful travelogue or entertaining film hits the spot with many groups.

If the winter-weather has been rough on the club's generator, a committee will need to step in and get it going before Field Day. Shown left to right: Al, K9OHJ; Burrell, K9JBZ; Dan, W9VEY; Dick, W9VWJ; and winding is Boyd, K9JFF.

A small club holding an annual "Ham Scramble" features contests for YLes and XYLs as well as the fellows. Trying to guess how many red-hot candies and buttons are in the jars are two "contesters." Watching are the chairman of the ladies game committee—(Right—Janean, W9BYQ; and second from right—Mary, K9WUA.)

One year an amateur magician kept everyone on the edges of their chairs.

After door prizes and awards for contest winners have been given, the party breaks up early enough that families will be home before the little people get too tired.

If a "Ham Scramble" appeals to your club, you'll be interested in the following list of committee chairmen who work together:

General Chairman and/or Co-Chairman
Registration
Publicity
Program
Dining Room and Decorations
Entertainment for Children
Contests
Exhibits
Prizes
Food
Kitchen and General Clean-Up

Some of these chairmen will also be needed if your club reserves a local restaurant once or twice a year for a banquet. A Reservations Chairman can handle ticket sales and deal with the Maitre D. Since parents usually hire babysitters for a banquet evening, the group will probably be adults and a dance or other entertainment can be planned to last into the late hours.

If you think you've got to have a reason for a party, don't overlook the Fourth of July, Halloween, Christmas, Valentine's Day and all of the wonderful holidays which offer lots of decoration and theme possibilities. A party during December will liven up the winter months when transmitter hunts

An annual dinner or party is a good chance to award amusing prizes or special honors for 100 per cent attendance during the year. The award recipients should, of course, know how to take a joke.

and outdoor activities are at a minimum. A family Christmas gathering may include a gift exchange set up with fun in mind. Hams can wrap radio components and keep them separated from toys brought by children for one another. Wives and girl friends should bring feminine type presents and put them in still another stack. With expenses at an all-year high at Christmas, perhaps a limit of $1.00 or less can be set on the exchange.

College campus clubs have problems of their own in party-planning such as time, location, money, and fresh ideas. The Michigan Tech Club of Houghton, Michigan, has a real gripe with 2200 fellows on campus, only 39 girls, and not a licensed YL among 'em. Unless the boys can find some girls for dances, record parties, or jazz fests, it looks like they'll have to be satisfied with something less. But an energetic gang of male hams should be able to organize some terrific transmitter hunts or spur-of-the-moment camping trips with portable gear. And if things get too gruesome, see what hams are doing in neighboring towns and pay up a school-term membership.

Admittedly, parties of all kinds require enthusiastic leadership, and when it spreads to the membership, any lack-of-interest problem will soon disappear. Chances are you'll find that your regular meetings as well as social gatherings will be lots more lively.

In the Good Old Summertime!

Shakespeare wrote about rare days in June, and hams talk about two in particular from one year to the next. The words "Field Dav" mean alot of things to alot of people: Hams themselves regard this special weekend as not only a perfectly legitimate reason to skip lawn mowing and house-painting but a chance to see how emergency power and portable rigs work out under less than ideal conditions. A non-radio minded wife may look at Field Day as a pretty poor excuse for the OM to escape visiting her relatives; and Joe Brown, the dedicated television watcher on the other side of town, may sound off about "that bunch of clowns who stay up all night running the noisiest generator they can find!"

But aside from these different views, Field Day is, of course, the June weekend when hams answer the "call-of-the-wild" and set up stations in gullies and hills everywhere.

Field Day is for fun and also to test what your club can do when the chips are down. How quickly can a portable station be set up? Are the generators capable of carrying the load? Can operators endure wind, weather, and long hours behind the mike? All these questions should have some kind of answer when time runs out on Field Day and everyone collapses in a heap.

Your club may feel that lack of preparation adds to the reality of the Field Day operation, but, let's face it, if somebody doesn't do some "getting ready," it may be a lost weekend. For instance, if the commutator of the generator has developed a case of dirt and grime, it will take some pre-Field Day cleaning; and who can claim that an efficient antenna system can be set-up, tested, and put on the air in only a couple hours.

In other words, it's the old "Be Prepared" motto again. Committees appointed in the spring can have Field Day equipment

Club parties will depend on the locale. For instance, the Midwest group shown above really go for spring and fall wienie roasts: Left to right: Rosi, K9ESY; Naoma, K9MSY; Jane, mother of K9RHL; Carole, K9AMD, and Claire, K9TST.

The Fixed Station Committee will supervise the assembling of complete Field Day stations and that may mean a lot of elbow grease. Left—Dan, W9EZA, and Dick, W9VWJ, move a rig into place.

ship-shape before the end of June. That doesn't mean that operators aren't going to be tested on how well they perform over a long haul or that the equipment itself isn't going to face a work-out; it just means that drastic repairs and replacements won't have to be made when the beginning Count-Down is on.

The extent to which your club goes "all-out" will determine what committees will need to pitch in. If you're planning a caravan to a weedy lot, you'll want someone with a mower to visit it first, and maybe one of the members who like to camp out can move in with a large tent and facilities.

Big clubs with lots of mobile stations, portable rigs, generators and lots of operators can and do work out elaborate plans using everything and everybody available. But, big or small, clubs depend on committees and here's a list to stimulate your thinking:

General Field Day Chairman and/or Co-Chairman
Antenna Systems
Portable power plans (Preparation and Fuel)
Fixed Stations
Mobile Stations
Operators (The Personnel Man)
Rig Repairs
The Big Count-Up.

Although several of the above titles speak for themselves, let's elaborate on a couple. The Fixed Station Committee will direct the assembling of complete stations on the various bands and also coordinate a pattern of operation. If, for instance, the gang on 40 meters in the pup-tent decides to switch bands, they should know that the fellows in the tent next door are working on 20 phone and don't care for local QRM in addition to what's on the band. Tempers will stay cool if everyone knows who's operating where.

The Mobile Chairman's job is to know whose car will be available and at what times. Since most drivers have only two hands, a log keeper with sharp pencils should be sent with each car.

The Operators' Chairman will serve as the Personnel Man to compile a list of available members. First, who wants to do the actual operating? Do they prefer phone or key? What class licenses do these folks have? It isn't too good to assign a novice to run a kilowatt rig on 14.250. Not only names but times are vital statistics, for you've got to remember that Field Day is a 24 hour affair. Let the fellows and gals pick their own hours, and by looking over the list you'll be able to separate the night owls from the early birds. Next, prepare a 24 hour schedule using every licensed ham to the best advantage and assigning non-licensed enthusiasts to log-keeping posts. Better have some alternates in case of emergencies.

Most clubs have at least one ham who'd rather work on equipment than operate it, and he can save the day (or night) if he's around when a rig goes sour. If stand-by stations can be thrown into use while repairs are being made, all the better; if not, just hope your man Friday will make himself available during the whole weekend.

Hot, cold, or lukewarm coffee is a "must" for Field Day; and it's safe to say that some kind of a pot, percolator, or pan is on the fire at 99 per cent of Field Day locations from start to finish. OMes are noted for their ability to make coffee in any kind of container but they'll admit that the XYLes do a good job, too. And they'll also note that it's pretty nice to have the wife and kids show up to see what "Daddy's been doing all weekend." If the ladies want to pitch

Bobbi, K9GOL, at the right pours hot coffee on Field Day night for a group of tired operators. The gals who keep the coffee flowing are popular around any operating site.

in and really make Field Day a family event, pot-luck meals and picnics can be planned. An extra popular gal is the one who fries eggs and bacon at 6 a.m. Sunday morning when eyes are red and beards are bushy. Keeping the coffee coming from dusk 'til dawn puts the ladies at the top of the Hams' Hit Parade.

When time runs out along with energy, a big chore remains—the tremendous task of log checking and scoring. If someone skilled in deciphering Egyptian hierioglyphics doesn't volunteer, a committee will be needed to sort, count, correct, total, and cull out errors. After this gigantic job has been done, the lists are bundled up and sent to the American Radio Relay League, 38 La Salle Road, West Hartford, Connecticut. There's nothing left to do then but wait for the nationwide totals to be released in their magazine, *QST*, and try to think how next year's Field Day in the good old summertime can be made a little better.

Other Contests

Field Day is by no means the one and only contest that your club can enter. Many clubs make an entire career out of the VHF contests. Some specialize in the VHF Sweepstakes in February, while others prefer to shoot for the September VHF Test. They sometimes go to rather great lengths in pursuing these contests.

Up Boston way hardly a VHF contest goes by without the Waltham, King Philip, or Rhododendron Swamp VHF Societies mustering of top of Pack Monadnock in New Hampshire or Mt. Greylock in northern Massachusetts for a king sized go. These fellows set up, even in mid-winter, with enormous beams on every VHF band, high power, and usually win the contest. Any group that hauls a 128 element two meter beam to the top of a mountain and sets it up on a tower deserves to win.

The Philmont Club leans more toward the DX Contests and just about every member is on there, hot a heavy, building up the club score. They use two meter intercoms, and the works. This contest runs in February and March every year.

In November we have the Sweepstakes Contest, another popular club effort. In October many clubs participate in the World Wide DX Contest.

All of these contests are good club projects. The members can work to help each other have their stations set up and also cooperate during the contests for the maximum number of contacts.

More next month.

. . . W5NQQ

Please Use Your Zip Code When Writing 73

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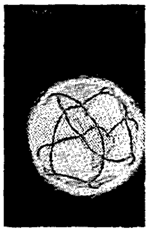
VHF HAM RADIO HANDBOOK



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Hamfest Schedule—Findlay, Ohio, Sept. 8; Peoria, Ill., Sept. 15; Cincinnati, Ohio, Sept. 22.

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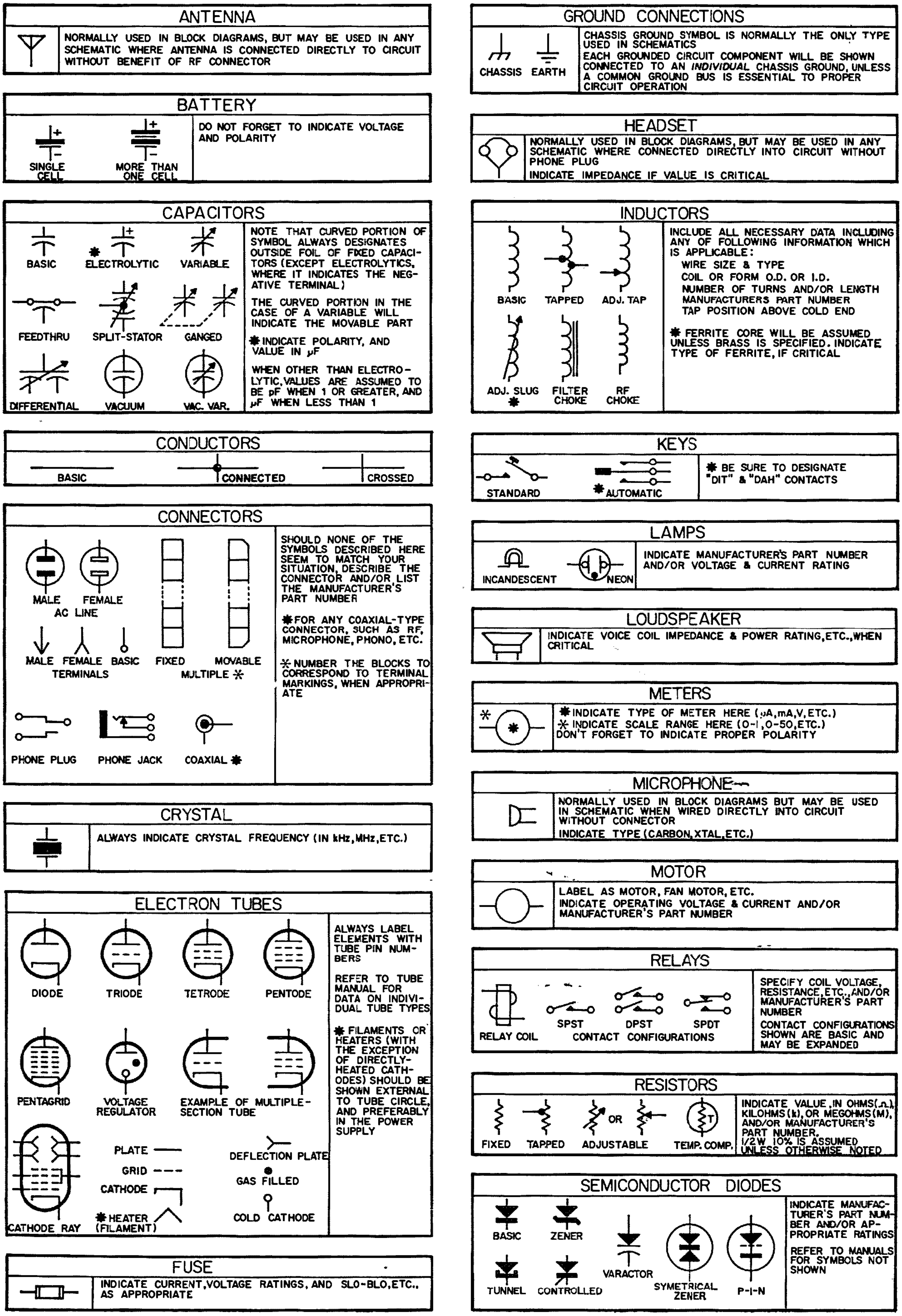

ELECTRONIC SYMBOLS

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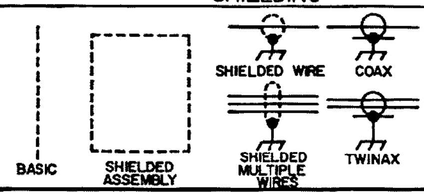

SHIELDS ARE ASSUMED TO BE GROUNDED UNLESS OTHERWISE NOTED

INDICATE IF SHIELD ON CONDUCTOR IS TO BE GROUNDED ONE END ONLY, & SPECIFY WHICH END

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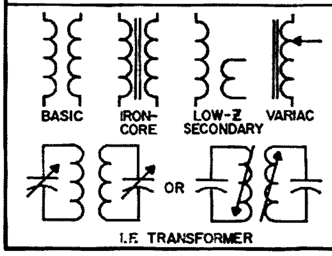
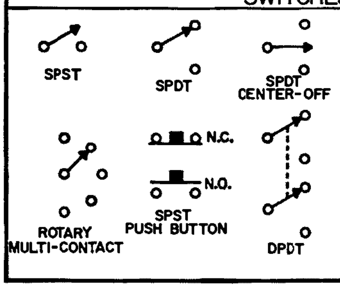


SHOW (4) LOOPS EACH WINDING EXCEPT (6) LOOPS ON HIGH-VOLTAGE SECONDARIES AND (2) ON FILAMENT WINDINGS AND NON-RESONANT LOW-Z RF COUPLING LINKS

TRANSFORMER DESCRIPTION SHOULD INCLUDE MANUFACTURER'S PART NUMBER AND RATINGS, OR CONSTRUCTION DATA

SWITCHES



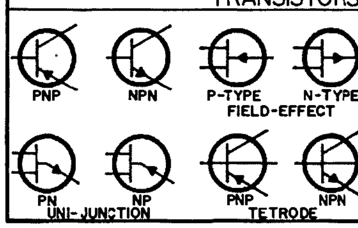
ONLY BASIC CONFIGURATIONS ARE SHOWN. COMBINE OR EXPAND AS NECESSARY TO SUIT

SELF-HOLDING SWITCH OPERATION IS ASSUMED UNLESS SPRING-RETURN IS SPECIFIED

NON-SHORTING TYPE IS ASSUMED UNLESS SHORTING TYPE IS SPECIFIED

SWITCH SECTIONS WHICH ARE SIMULTANEOUSLY OPERATED OR GANGED SHOULD BE JOINED WITH A DOTTED LINE

TRANSISTORS



SPECIFY MANUFACTURER'S PART NUMBER OR RATINGS

REFER TO TRANSISTOR MANUALS FOR TYPES NOT SHOWN HERE.

ELECTRONIC ABBREVIATIONS

(AS USED ON DRAWINGS AND SCHEMATICS)

NOMENCLATURE	ABBREVIATION(S)
ALTERNATING CURRENT	AC
AMPERE	A
AMPLIFIER	AMP
AMPLITUDE MODULATION	AM
ANTENNA	ANT
AUDIO FREQUENCY	AF
AUTOMATIC FREQUENCY CONTROL	AFC
AUTOMATIC GAIN CONTROL	AGC
AUTOMATIC VOLUME CONTROL	AVC
BATTERY	B
BEAT FREQUENCY OSCILLATOR	BFO
BROADCAST	BC
CAPACITANCE, CAPACITOR	C
CONTINUOUS WAVE	CW
CRYSTAL	X, XTAL
CURRENT	I
DECIBEL	dB
DIODE, SEMICONDUCTOR (ALL TYPES)	D
DIRECT CURRENT	DC
DOUBLE COTTON COVERED	D.C.C.
DOUBLE POLE DOUBLE THROW	DPDT
DOUBLE POLE SINGLE THROW	DPST
DOUBLE SILK COVERED	D.S.C.
ELECTRON TUBE (ALL TYPES)	V
ENAMEL COVERED	ENAM
FILAMENT	FIL
FREQUENCY	FREQ, f
FREQUENCY MODULATION	FM
FUSE	F
GROUND	GND
HENRY	H
HERTZ (CYCLES PER SECOND)	Hz
IMPEDANCE	Z
INDUCTANCE, INDUCTOR	L
INSIDE DIAMETER	I.D.
INTERMEDIATE FREQUENCY	I.F.
JACK	J
KILOHERTZ (KILOCYCLES PER SECOND)	kHz
KILOHM	k, kΩ
KILOVOLT	kV
KILOWATT	kW
LAMP	I
LOUDSPEAKER	SPKR
MEGAHERTZ (MEGACYCLES PER SECOND)	MHz
MEGOHM	M, MΩ
METER	M
MICROAMPERE	μA
MICROFARAD	μF
MICROHENRY	μH

NOMENCLATURE	ABBREVIATION(S)
MICROPHONE	MIC
MICROVOLT	μV
MICROWATT	μW
MILLIAMPERE	mA
MILLIHENRY	mH
MILLIVOLT	mV
MILLIWATT	mW
NEGATIVE (POLARITY)	−, NEG
NORMALLY CLOSED	NC
NORMALLY OPEN	NO
OHM	Ω
OSCILLATOR	OSC
OUTSIDE DIAMETER	O.D.
PICOFARAD	pF
PLUG	P
POSITIVE (POLARITY)	+, POS
POWER AMPLIFIER	PA
PRIMARY	PRI
PUSHBUTTON	PB
RADIO FREQUENCY	RF
RADIO FREQUENCY CHOKE	RFC
RECEIVE	REC
RECEIVER	RCVR
RELAY	K
RESISTANCE, RESISTOR (ALL TYPES)	R
ROOT MEAN SQUARE	RMS
SECONDARY	SEC
SHORTWAVE	SW
SINGLE COTTON COVERED	S.C.C.
SINGLE POLE DOUBLE THROW	SPDT
SINGLE POLE SINGLE THROW	SPST
SINGLE SILK COVERED	S.S.C.
SWITCH	S
TIME	t
TRANSFORMER	XFMR, T
TRANSISTOR (ALL TYPES)	Q
TRANSMIT	XMIT
TRANSMITTER	XMTR
ULTRA HIGH FREQUENCY	UHF
VACUUM TUBE VOLTMETER	VTVM
VERY HIGH FREQUENCY	VHF
VOLT OHM METER	VOM
VOLT, VOLTS	V
VOLTAGE	E
WATT	W
WAVELENGTH	λ

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply. I recently got a request from a reader asking me what to do about mobile noise. What kind of noise? He didn't specify any details. I gave him a general answer and made some suggestions, but it would have been helpful if he had described the kind of noise, under what circumstances it occurred, and what he had already done to try to eliminate the problem. Be specific about what you want. We are not mind readers.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TTZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland. Oregon 92705. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements. ■

local and state police. Talk with your local newspaper and radio or television station. Put the word out through the CB group. It is a good idea to canvas all other users of mobile radio in your area too so that if anything is reported by any of them the word will be passed along immediately to you. This could be any doctors with mobile radio, power company trucks, road crews, delivery trucks, taxis, the telephone company, etc.

Our net is tied in with NICAP, the most energetic organization in the country investigating the UFO reports. Net members and net controls will be expected to get in touch with their local NICAP investigating groups so they can coordinate with our net. Your local NICAP man may have an interesting UFO slide show that can be put on for your club. You might drop a line to NICAP, 1536 Connecticut Ave., Washington DC 20036. Membership is $5 and well worth while.

Even without any on the air alerts, the mere establishing of our net will provide both a useful service for any types of emergencies and a medium for excellent public relations for amateur radio . . . which we can definitely use. Try and get your local paper to do an article about your participation in the net. Perhaps you can get interviewed on the radio station. Talk about amateur radio.

NICAP reports that sightings have been way down for the last few months. Perhaps the UFO people are boycotting us in protest over the University debacle? Or are they worried over our UFO reporting net? Come on out, UFO's, let's see you. I do hope I am sitting by with a tape recorder when the net gets its first UFO report. That will be a historic bit of pandemonium to have on tape. I keep one of those little cassette recorders by the rig now at all times . . . never know when something interesting might happen.

I would particularly like to thank Chuck, W5GDQ (Dallas) for his net control work with the UFO net, right from the beginning. Chuck has only missed one net control so far, and that was when he was out of town.

Auto-Call Wanted

As our net grows more and more operators will be wanting to be able to be alerted whenever something is reported anywhere in the country. Few of us are going to just leave the receiver tuned into the frequency waiting for that call. What we need is a fairly fool-proof calling system. I should think that some sort of tone system . . . or perhaps

two tones might work. There are some fairly sophisticated filters available these days. We are open for articles along this line.

Slow Scan Television

The FCC apparently has finally come through with the slow scan tv permission. We'll have the exact frequency allocations by and by. This rule change has been hanging fire for about seven years now. Opponents to the proposal grumble that the slow scan signals are horribly wide and make a mess in the phone bands. Proponents point out all the things we can do with slow scan. We shall see more of both sides.

We have a couple of slow scan articles in the works here and will publish them as soon as we can. We are interested in more. Andre of Vanguard Labs has an idea that you might like to play around with . . . he is working on a system that will use a regular tv camera and monitor. Then you would record the signal on a drum and slow down the drum for radio transmission. The signals would record on another drum at the other end and this would speed up and the picture could be seen on the monitor. Instead of using a slow phosphor viewing tube you would just repeat the same picture over and over.

At any rate, slow scan is here so let's see what we can do with it. Let's try to cause as little QRM with the signals as we can and see what kind of interesting systems we can work out. It wasn't very many years ago that there were a lot of laughs when I proposed a WAS certificate for RTTY. Now it is time for one for television!

Your Advanced Class License

Our series on the Advanced License Study Course is winding up this fall. If you've followed the series you should have no trouble at all in getting your ticket and keeping most of your allocations. We will continue on with a study guide for the Extra Class and, I suspect, eventually go back and provide you with a course for the General Ticket.

Many of our readers write to tell us that the course is being used with great effectiveness by their clubs, with an hour or so devoted to questions and answers at the beginning of each club meeting based upon the current text. When the series is done we will bring the whole thing out in a separate book which can be kept at hand for future club courses. . . . Wayne

WTW Report

Since the last report, conventions and hamfests have caused QRM and we missed the last issue of the magazine. We now have a good system lined up, so my service to all of you will be speedier and more efficient. Remember . . . send all reports directly to me. Don't send anything to 73 Magazine. I have all the certificates here and am sending them directly.

We still need a good club in W/K1, W/K2, and W/KØ, as well as Africa for WTW card check points.

There seems to be some confusion about phone certificates. SSB and AM are both phone, and count toward the award for either mode.

Regarding Don Miller's cards . . . we are only accepting the ones that ARRL accepts toward DXCC, thus no one can say we make our rules as we go along. We accept as a country any spot recognized by any national radio society. If ARRL accepts, we do too. If RSGB accepts it we do too, Send 25¢ to get a copy of the country list/tally sheet. This will relieve any doubts you might have.

There are strong rumors that a number of fellows are getting close to WTW-300 on 20 now. I wonder who will be first to qualify? Check your cards very carefully as we look them over with a critical eye and will disqualify any which show they have been tampered with.

To make the task of anyone checking your cards for the awards easier, I strongly suggest, when possible, to have all QSO information on one side of the card, along with your call sign in fairly large letters. Next time you have QSLs printed, how about keeping this in mind? The business of flipping cards over and over when checking them can become a chore and requires twice the time.

Remember, to qualify for WTW, all contacts must have taken place after May 1, 1966.

The following stations have qualified for WTW since the last listing:

WTW-200, 14 MHz Phone:

Certificate #11, K8YBU
12, PY3BXW
13, W6MEM

WTW-100, 14 MHz Phone:
54, K5TGJ
55, K4VKW
56, SVØWL
WTW-100 21 MHz Phone:
13, W6MEM
14, K4VKW
15, WA1EUV
WTW-100, 21 MHz CW:
5, WØRRS
WTW-100, 14 MHz CW:
15, K4CEB

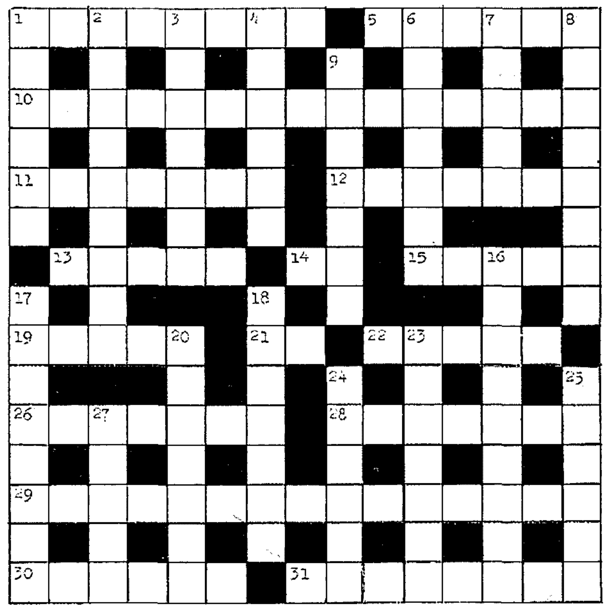
21 MHz Phone still has only W4OPM with #1, and 28 MHz both Phone and CW still await someone to pick up #1.

As soon as enough scores are received, I will start a running list of the number of countries various fellows have worked.

. . . W4BPD

CROSSWORD
by

Michael Kresila
Box 57
Marion, Ohio 43302



Across

1. An amplifying station used to boost the volume on long telephone lines.
5. Noise heard in a receiver due to atmospheric disturbances.
10. The lack of dilution of a hue by white.
11. Flyback.
12. An electrode used to initiate conduction at the desired points in each cycle.
13. Undesired sound.
14. Aluminum. (Abbr.)
15. To make merry.
19. A series of names, numbers and words.
21. A world-governing body. (Abbr.)
22. The centimeter-gram-second electromagnetic unit of a magnetic induction.
26. Also called piggy-back control.
28. Trade name for a phenolic compound having good insulating qualities.
29. Use of radio signals for course-plotting.
30. To push with sudden force.
31. An electrode whose primary function is to reverse the direction of an electron stream.

Down

1. To preserve for later reproduction.
2. A high-vacuum thermionic tube used to control the magnitude of current flow. (Pl.)
3. Also called antennas.
4. An ionized layer in the atmosphere, about 55 to 85 miles above the earth's surface.
6. Representation of an operating system by computers and its associated equipment and personnel.
7. The rotation of a cross-section of a waveguide about the longitudinal axis.
8. The parts of a digital computer which carry out instructions in proper sequence.
9. Capable of being heard.
16. The transmitted portion of the suppressed sideband.
17. A dielectric that retains a charge after the charging field is removed.
18. A metallic alloy having special magnetic properties.
20. Fixed set of plates in a variable capacitor.
23. Slang expression for radio broadcasting.
24. A position of authority or trust.
25. A refinement added to an impedance bridge to avoid the effects of capacitance to ground.
27. A device, also known as acoustic radar.

Solution Pg. 106

Solution To Puzzle on Pg. 118

1 R	E	2 P	E	3 A	T	4 E	R		5 S	6 T	A	7 T	I	8 C
E		L		E		L		9 A		R		N		O
10 C	O	L	O	R	S	A	T	U	R	A	T	I	O	N
O		O		I		Y		D		I		S		T
11 R	E	T	R	A	C	E		12 I	G	N	I	T	O	R
D		R		L		R		B		E				O
	13 N	O	I	S	E		14 A	L		15 R	E	16 V	E	L
17 E		N				18 X		E				E		S
19 L	I	S	T	20 S		21 U	N		22 G	23 A	U	S	S	
E				T		X		24 O		I		T		25 X
26 C	A	27 S	C	A	D	E		28 F	O	R	M	I	C	A
T		O		T		T		F		N		G		G
29 R	A	D	I	O	N	A	V	I	G	A	T	I	O	N
E		A		R		L		C		V		A		E
30 T	H	R	U	S	T		31 R	E	P	E	L	L	E	R

YOUR CALL

Please check your address label and make sure that it is correct. In cases where no call letters has been furnished we have had to make one up. If you find that your label has an EE3*&* on it that means we don't know your call and would appreciate having it.

Propagation Chart

September 1968

ISSUED JUNE 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	14	7	7	7	7	14B	14	14	14	14
ARGENTINA	21	14A	14	14	7A	14	21A	21A	21A	21A	21A	21
AUSTRALIA	21	14	14	7A	7A	7	7B	14	14	14	21	21A
CANAL ZONE	21	14	14	14	7A	7	14A	21	21	21A	21A	21A
ENGLAND	7A	7	7	7	7	14	21A	21	21	21	14A	14
HAWAII	21	14	14	7A	7	7	7A	7B	14A	21	21	14A
INDIA	14B	7B	7B	7B	7B	14	14	14A	14A	14A	14	14B
JAPAN	14	14	7B	7B	7B	7B	7	14B	14B	7B	14	14A
MEXICO	21	14	14	7A	7A	7	14	21	21	21	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7B	14B	14	14	14	14	14
PUERTO RICO	14	7A	7A	7	7	7	14	21	21	21	21	21
SOUTH AFRICA	14	14	7B	14	14	14A	21A	21A	21A	21A	21A	21
U. S. S. R.	7	7	7	7	7	14	14A	14A	14A	14	14	7B
WEST COAST	21	14A	14	7A	7	7	7A	14A	21	21	21A	21A

CENTRAL UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14A	14	14	7	7	7	7	7	14	14	14	14A
ARGENTINA	21	14A	14	14	14	7	21	21	21A	21A	21A	21
AUSTRALIA	21A	21	14	14	14	7A	7B	14	14	14	21	21A
CANAL ZONE	21A	14A	14	14	14	7A	14	21A	21A	21A	21A	21A
ENGLAND	7A	7	7	7	7	7	14	21A	14A	21	14A	14
HAWAII	21A	21	14	14	7A	7	7	7B	14A	21	21A	14A
INDIA	14	14	14	7B	7B	7B	7B	14	14	14A	14	14B
JAPAN	14A	14	14	7B	7B	7B	7	7	14B	7B	14	14A
MEXICO	14A	14	7	7	7	7	7	14	14A	14A	21	21
PHILIPPINES	14A	14	14	7B	7B	7B	7B	7A	14	14	14	14
PUERTO RICO	21	14	14	7A	7A	7	14	21	21	21	21	21A
SOUTH AFRICA	14	14	7B	7B	7B	7B	14A	21	21A	21A	21	21
U. S. S. R.	7B	7	7	7	7B	7B	14	14	14A	14	14	7B

WESTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	14	7	7	7	7	7	7	14	14	14
ARGENTINA	21	21	14	14	14	14	14	21	21A	21A	21A	21
AUSTRALIA	21A	21A	21	14	14	14	14	14	14	14	21	21A
CANAL ZONE	21A	21	14	14	14	7A	14	21	21A	21A	21A	21A
ENGLAND	7A	7	7	7	7	7	7B	14	14	14A	14A	14
HAWAII	21A	21A	21	14A	14	14	14	7	14A	21	21A	21A
INDIA	14	14A	14	7B	7B	7B	7B	7B	14B	14B	14	14B
JAPAN	21	21	14	14	7	7	7	7	14	14	14	14A
MEXICO	21	14A	14	7	7	7	7	14	21	21	21A	21A
PHILIPPINES	21	21	14	14	7	7	7	7	14	14	14	14A
PUERTO RICO	21A	14	14	14	7A	7	14	21	21A	21A	21A	21A
SOUTH AFRICA	14	14	7B	7B	7B	7B	14	14A	21	21	21	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	14	14	14	14	7B
EAST COAST	21	14A	14	7A	7	7	7A	14A	21	21	21A	21A

A. Next higher frequency may be useful at this hour.

B. Very difficult circuit at this hour.

Good: 1, 2, 8-13, 16, 17, 19-27

Fair: 3, 4, 6, 7, 14, 18, 28-31

Poor: 5, 14

Note: VHF forecasts have been discontinue due to lack of reliable information.

Dear 73,

After reading some tower construction articles in the July issue of 73, I had a horrible thought; does the average ham realize what the common termite might do to a wooden tower, if given the chance?

Anyone constructing a wooden tower should take all precautions to prevent damage by termites or other pests or decay. Consult your local lumber or hardware dealer for the necessary materials to treat the wood and nearby ground to prevent any such damage.

George S. Stevens WB2ZFA
Mays Landing, N.J.

Dear 73,

I want to take this opportunity to comment on the incentive license study sections in your magazine. I think they are the best. Really, I'm learning more by your type of presentation than I ever could out of the Handbook. I believe that basically the Handbook is designed fror a person who has a basic knowledge of electricity and a little experience of the same. Coming in cold with absolutely no knowledge, the Handbook is very confusing to me. Most of the other hams in the club here think the same. In other words, fine business.

G. Gerald Burger WAØKUA
Secy. Huron Amateur Radio Club

Dear Kayla,

Decidedly like what you are doing. The humor is splendid and your Advance Class course is excellent. Keep laughing and the temptation to wring your hands is not so great. 88 to you too.

Jim Kaufman WAØRD
Boulder, Colorado 80302

Dear Kayla,

The big "40 meter push" which you presented in *73* depicts the beginnings of an excellent campaign. I'm all for, and would like to see *73 Magazine* present and lead a year long marathon designed to eliminate the interference caused by commercial stations on 40 meters. If 73 would follow through with such an "elimination marathon", I promise to urge most of the hams with whom I come in contact to support the campaign.

Possibly *73* can print up some pre-written complaint letters to be signed and mailed by US hams to Radio Moscow, VOA, BBC, etc. I bet we can lick the interference problem in one year with cooperation. How about it *73?*

Marty Hartstein WB6NWW
Long Beach, Calif.

OK, fellows, what say? I'll print up some form letters to be used as petitions. Let's give it a try. It can only cost postage and the work in getting signatures. Any other ideas from readers as to how to better make use of 40 will be appreciated and put to use.

Dear Wayne, Kayla, and Lin,

After a one year trial subscription I decided that *73* was great. I must say your editorials are right on the beam, so to speak. They are my thoughts entirely on almost every subject.

Keep up the good work and put in more humorous articles like Dilemma in Surplus (June '68). Keep putting in lots of ads, I read them word for word. And . . . best of all, put in more pictures with the articles, especially ones about decibels! HI HI.

Brent Christensen WAØSTS

Dear 73,

Thought that I would let you know that as lousy as the mail service is over here, I finally received my February issue of your most welcome bit of ham news from the States. My subscription was mailed to you in November at the same time that I mailed subs to the other two. I am getting 73 quite regularly even though late. I must say that I am a bit disappointed with the other two magazines as I have yet to receive my first copy. As you well know, there is no operation here and our only contact with the ham world in the states is through your magazines for which we are very appreciative. There are five hams in our group and by the time the magazine gets around, it is well dog-eared and equally as well read and appreciated. Keep up the good work. Just thought I would toss the roses where they are justly due. We do make good use of it and it does get passed around and then filed in the operating room.

Herb Wright WB6IHE
Saigon, So. Vietnam

Dear 73,

With great interest I read W2NSD's editorial on UFO's. I have been interested for several years in this subject. My views parallel those of the editorial and I hope in the near future I can assist in this proposed program. I do not know if there are any amateurs on this side of the pond that are interested but will do my best to find out. I think it would be of great value to have an arm of the network in Europe. I will keep my ears on 14250 and in the meantime try to scare up some interested parties on this end.

Richard J. Malby
APO New York 09176

Dear 73,

All US hams and relations visiting Spain are all times welcomed at the home of very old OM, V. S. Alexandersen, well known in the Amateur World between 1927-1936 as ET2X, ET3CS and ES3CX. I'm not active anymore, but I'm still a ham. Address Camino Son Toells 37, St. Augustin, Palma De Mallorca, Baleares, Spain.

V. S. Alexandersen

Dear 73,

Please pass along the word that I still have a bulk (300+) of National Zip Code Directory flyers to pass out free to anyone sending a request.

Earle and Marilyn McIvor
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WANTED, ANY CONDITION; VOM, VTOM, Weatstone Bridge. Resistance Decade Box, meter monuments. Gil Barber, 4155 E. Carey, Las Vegas, Nevada 89110.

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MODEL #28 KSR, $295.00. Write for list of 10 years' surplus, RTTY, FAX, etc. G. White, 5716 N. King's Highway, Alexandria, Virginia 22303.

WANTED: Issues of 73. Oct. '60 to Dec. '62, Jan. '66 to Dec. '67. Kirt Fanning, 6021 Edgewood, LaFrange, Ill. 60525.

FOR SALE: Motorola 80-D, 12v, complete and a Link 50ufs, 110v base complete, both on 52.525HZ. $120 for the pair. WA9GVE, 7424 Illinois Rd., Fort Wayne, Indiana.

FOR SALE: Clegg Apollo Six Linear Amplifier. Brand new! Below cost! Contact Jack Batts, Five Old Tavern Road, Wayland, Mass. 01778. Phone 653-6891.

NORELCO VIDEO TAPE RECORDER in perfect condition, tape and all additional parts included; CCTV camera—$115.00, Vidicon—$10.00, Vidicon Yoke—$10.00, Elgeet 4" Telephoto lens—f2.7; Reverb—$15.00; Simpson 260 VOM—$35.00; Heath RF Signal Generator IG-102, $15.00; EICO R-C Bridge & RLC Comparator—$18.00; Tachometer—$10.00. Wanted: 6M SSB Transceiver. WB2GKF, 506 Mount Prospect Avenue, Clifton, N.J. 07012.

FOR SALE: Complete Hallicrafters station in excellent condition. HT-37, and SX-100 with R-66B speaker. $300. James Winter, RR 2, Huron, S.D. 57350.

THE HAM-DINGER: Warren (Ohio) A.R.A. 11th Annual Hamfest, Sunday, August 25, Newton Falls, rain or shine. Follow arrows from Rt. 534 or Turnpike Exit 14. Talk-in stations, 10-6-2-. Prizes, swapshop, homebrew-code contests, XYL-YL program, ragchews galore. Food sold or bring picnic. For Hamfest bulletin write W.A.R.A., Box 809, Warren, Ohio 44481.

TWO METER FET PREAMPLIFIER. Typical specifications: 12 DB or better gain with less than 2DB noise figure. $10.95 postpaid. Communications Associates, P.O.B. 13275, St. Petersburg, Fla. 33731.

HALLICRAFTERS HT32B; $275; NC-300, $125; matching pr 813's GG linear with pwr supply, $50; TR-4 with ac pwr supply and speaker, $500. Beautiful. K6SUQ, 5 Rydal Court, Orinda, Calif. 94563.

WANTED: Heath-VX-1. Also G-76 AC power supply, must be in fine condition. Cash. G. Gysan, 53 Lothrop St., Beverly, Mass. 01915. Phone 922-3850.

FOR SALE: VHF EQUIPMENT: 6 meter SSB, HX-30 and HA-20 linear, factory wired, mint condition with manuals, $245.00. Gonset communicator II-B, 6 meters, 12/117v in mint condition with manual, $115. Gonset #3350, G-76 DC power supply (all transistor), $50.00. W1VYB-J. Gysan, 53 Lothrop Street, Beverly, Mass. 01915. Phone: 922-3850.

TOROIDS, uncased 44 or 88mH, also individually epoxy encased 88mH for standards, any 5, $1.50. 255A relay $2.10, 18B socket 70¢ all PP USA. E. W. Evans, K4OEN, 220 Mimosa Ln., Paducah, Ky. 42001.

"SAROC" FOURTH ANNUAL fun convention scheduled January 8-12, 1969, in Hotel Sahara's new space convention center, Las Vegas, Nevada. Advance registration closes January 1, 1969. Ladies program in Don the Beachcomber. Technical seminars, FM, MARS, RTTY, QCWA, WCARS-7255. Registration $12.00 per person entitles "SAROC" participants to special room rate $10.00 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Sahara's late show, Sunday breakfast equal to any banquet dinner, ask any "SAROC" veteran. Brochure planned November mailing for details QSP QSL card with ZIP Southern Nevada ARC, Box 73, Boulder City, Nevada 89005.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail. 3-lbs each shipping wt., FOB. P. Wandelt, RD # 1, Unadilla, New York 13849.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

CLEGG VENUS 6 M SSB serial 100 33 w/ac ps and APOLLO LINEAR 1200 265. Both units recently factory checked. Included SS Booster 708 308. Everything $450.00. Eastern Penna. Write Box 968, c/o 73 Magazine.

SELL. Excellent CE100V, $495. Kent Markel, Box 144A RR 1, Lexington Park, Maryland 20653. 301-863-5967.

FOR SALE: SX101—$100; Knight R100A—$70; Ranger II—$150; DX60—$40; HW32—$75. Don Ahonen, Rt. 1, Bx 291A, Lisle Road, Owego, New York 13827.

WANTED: HA-10 LF/MF tuner, new or used. F. Rafalowski, 525 Home Ave., Trenton, New Jersey 08611.

SELL/TRADE: Collins mechanical filters, F455N-20 (2kc), F455N-30 (3kc), F455N-40 (4kc), on partially canabalized Collins sub-chassis 5407577006. Will remove filters or send sub-assembly. Trade for or buy 500kc filters for 51J4 receiver: F500B-31, F500B-14, F500B-08, or what have you that fits? W. A. Kernaghan, 1752 Kilohi St., Honolulu, Hawaii 96819.

FOR SALE: Thunderbolt. Complete with spare tubes. Will ship. $225. K6HLO, 511 Oak St., Roseville, California 95678.

THE CENTRAL NEW YORK CHAPTER OF QCWA will hold its annual banquet and meeting on September 28, 1968, at Hanson's Hotel, Oquaga Lake, Deposit, New York. Cocktail QSOs from 5 to 7 p.m. Buffet dinner at 7 p.m. and business meeting and election of officers at 8:30 p.m. All QCWA members are invited to attend and enjoy this program. Use exit 83 from the East, exist 82 from the West, on route 17. Tickets $5. For further information contact Clark Galbreath W2AXX, 111 Keeler St., Endicott, N.Y. 13760.

FOUR CORNERS FIELD DAY! September 21, 22. Club station K5WXI will operate 15, 20, 40 and 80 meters SSB and CW day and night. "5 Ø 7" award for working this station.

THE FOUNDATION FOR AMATEUR RADIO will hold its annual Hamfest on Sunday, September 22 from 1000 until 1700 hours at the Gaithersburg Fairgrounds in Gaithersburg, Md.

THE IOSCO RADIO CLUB presents its 4th annual Northeastern Michigan Hamfest on October 4, 5, 6 at East Tawas, Mich. 60 miles north of Bay City on US 23. Programs will begin Friday, October 4, at 6 p.m. ending Sunday afternoon at 3 p.m. For additional information contact Jerry Mertz W8DET or Glenn A. Pohl K8IYZ.

October 1968

73¢

73

AMATEUR RADIO

RECEIVERS

Thoughts on Receiver Design

3 Tube Super Het Receiver

Midnight Oil Receiver

High Performance Receiver for 2

Mobile Noise Suppression

AVC Circuits

Regen Detector

And Many More in this Issue

73 MAGAZINE

October 1968
Vol. XLVII No. 10

Cover Photo: A collection of current receivers available. Top to Bottom and Left to Right: Radio Shack Realistic DX-150, Hallicrafters SX-130, Davco DR-50, Hammarlund HQ-215, Galaxy R-530, Heath SB-301, R.L. Drake R-4B, with the Amphenol 830 Transistor Analyzer, McCoy Silver Sentinel Crystal Filter and associated oscillator crystals. Photo by Fred Meyer Studio.

Next Month: Look for an article by Fred Clepper, W3RET on the application and selection of crystal filters.

Contents

Departments

73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S. Entire contents copyright 1968 by 73, Inc. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

de W2NSD/1

Miller & CQ

In view of the confession of Miller about his hoax expedition I was wondering how CQ would handle this disaster to their Miller series and their Miller DX Handbook. They did beautifully. After reading the CQ editorial I was left with the distinct impression that Don Miller had been most kind and gracious to the ARRL in letting them off the hook on his libel suit. No mention was made whatever of the hoax or the confession. Nothing was said at all about his evasions on questions about many other trips of his. I think CQ should certainly win the Baron Munchausen award for Forthright Reporting for 1968.

Silver Futures

As I find myself wearing out from these foolish 16 hour work days it is not too unnatural for my mind to turn to alternate means for survival in this world. More and more I've been getting interested in the stock market. Lot of money there.

In talking with one of our advertisers I mentioned my interest and he poo-poohed the market. The real money is in comodities, he explained. Take silver, for instance . . . it is in short supply and going to get in nothing but shorter supply . . . right? So how do you make money from that simple bit of information? He explained about how simple it was to buy a "silver future" . . . that you only had to put up 10% of the cost and the rest was on margin. You could make thousands of dollars. That sounded pretty good. I did like the ring of that.

My local broker quickly bought one silver future for March 1969 for me. A bargain at only $27,000! I had to put up only $2700. My friend was right . . . two days later my future was up to $27,500 . . . I'd made $500 in two days! Well, if I'd sold out right then I would have made $500 in two days. But that future was headed towards $30,000 by the end of the year, at the very least, my friend had explained. In the next five days it dropped daily, arriving at the $25,000 mark. Oi! My friend said not to worry, just a little fluctuation. Silver is in short supply and the price has to go up. I nervously held tight. Sure enough, for five days it went up, reaching $27,000 again. Whew! Four days later it was down to $25,000 and I was a nervous wretch. A few days more and it was back to $26,000. I called my broker to see what he had to say . . . "I'm a bear on silver," said he. Hmmm. "Sell," said I. I got out at $26,000 and watched the March futures skid down to under $22,000. Perhaps I should have bought a future down there, but somehow every time I started to pick up the phone my arm went numb and I put it off.

Publishing may require long hours, but it isn't so bad.

Post Office

It seems to me that our mail service may well be headed for extinction. As the rates go up and the deliveries go down, something else is bound to take its place. Of course I feel that the post office could easily automate if they had the inclination. By standardizing on an envelope size and authorizing a simple addressing machine which could be read by a computer they could get most of the mail in shape so it could be sorted and handled entirely by machine. A special low postage rate would force all commerical users and prudent private persons to use the new service.

The addressing machines could vary from a $5 Dymo type contraption to regular typewriters. I'll bet they could turn them out to sell for $2.

I've wondered why AT&T hasn't taken advantage of their extensive wire facilities which go into virtually every home and business in the country and put in small Teletype-type of printers which would permit you to type up a letter and then feed it into a tape for instant transmission to any other similar machine. The printers would cost a little more than a phone, but would permit almost instant mail. I'll bet they could turn out a small printer, complete with built in tape recorder, for under $200. That's $20 a year for 10 years. You'd type your letter and it would record on tape. You could play it back on your own printer if you wanted or else just push the button and it would be sent to your local

Please turn to page 118

UFO

Late in July headlines were made all over the U.S. when Dr. McDonald, senior physicist at the University of Arizona's Institute of Atmospheric Physics, indicated a probable connection between UFO's and the power blackouts. This theory is strongly substantiated in Fuller's book, "Incident at Exeter." available in paperback.

Just about everyone involved in studying the UFO reports is in agreement that now is the time for a step up in the investigation of these objects. Russia, despite some conflicting reports, is going all out to investigate and photograph UFO's. Amateur radio has it in its power to do more to help bring light to this mystery than any other group in the world. Only amateur radio reaches into every community in our country and makes it possible to provide the fast communications that will be needed to alert investigation teams along the line of UFO travel.

If we get to work on this we can set up the most comprehensive alerting network the world has ever seen. We can tie in every other communications system to our amateur net . . . we can include all users of mobile radio, marine radio and aircraft radio . . . all fixed stations . . . military . . . government services . . . UFO watching groups . . . fire tower watchers . . radio and television stations . . . everything. If each of us sets up a liason in his own area to all other services and interested parties to receive and forward any UFO reports we can achieve this vast system.

Between NICAP and APRO I suspect that we will all be able to find at least one person in any area who is interested in helping to solve the UFO mystery. If we ask him to set up the liason by phone to receive reports of any sightings in the area from any source and pass them on to you and, in turn, to pass along any alerts you get via amateur radio to those interested. The net can be set up with a minimum of responsibility on your shoulders. Of course if your wife is interested in acting as the liason then she could handle that aspect of the net. The liason man should be available most of the time and have two phones . . . one for incoming calls and the other to pass along messages to you or others who should get the word.

If you can fire up on 14.3 MHz and can devote a bit of time to helping to solve this UFO problem as well as enormously aiding the radio amateur image in your community then get started by checking in at 0200 GMT (10 pm EDT) on any night and reporting your interest. Next drop a line with SASE to NICAP, 1536 Connecticut Ave. NW, Washington 20036 and ask them for the name of a person interested in UFO's in your area that might be able to work with you on this. If you want to handle it all yourself then just get to work contacting the local papers and giving them the story of the net and your service with the net. Same for radio and television stations. Promise all of them full cooperation on incoming reports if you get immediate reports from them of anything hot.

After you've contacted your local CB group, police, fire, CAP, road department, public service, telephone company and doctors with mobile radio then start looking for other mobile radio users and groups or individuals that might either be able to report sightings or benefit by knowing of probable sightings. You will certainly get to know a lot of people in your community.

You don't have to profess any belief or disbelief in UFO's. That is one of the purposes of the net . . . to pin this whole matter down as quickly as we can and either make it possible for positive identification of these things or else to expose them for what they really are.

The nice part of it is that we can provide an enormous public service, complete with great benefit to amateur radio. When we get this going well we should be getting a good deal of national promotion . . . and we may see more fellows getting interested in amateur radio and find Congress more interested in helping us. Even the FCC may begin to realize that we exist.

One other point that you might not have considered . . . when you are the hub of this

(*turn to page* 121)

A Collection of Thoughts on Receiver Design

Clifford Klinert WB6BIH
520 *Division Street*
National City, Calif. 92050

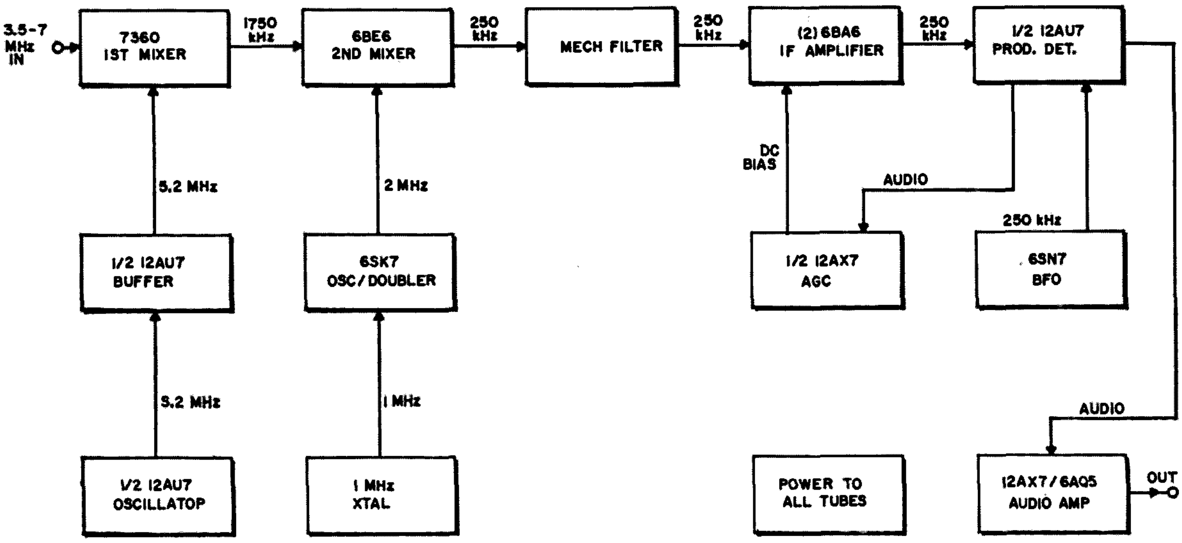

Fig. 1. *Block diagram of the receiver.*

The purpose of this article is to outline some of the difficulties which can be encountered in home construction of amateur band receivers. This is not intended to be a construction project and no parts values will be given, but will deal with the general problems encountered in a year long receiver design and construction project. Although the field of receiver design and homebrewing may seem beyond the grasp of most of the casual weekend builders, if a real desire or need exists for an individual to achieve a goal, a little effort and organization, and a lot of patience can lead to a great deal of satisfaction. It is with this spirit and determination that this article is written.

Prerequisites

There are a few basic preliminary requirements to fulfill in order to complete a receiver project, or any project. The ones that have been found to be important are listed below.

1. *Experience*: This is the most important factor, and is usually dependent on considerable homebrewing and project construction in the past. However, even with a limited background of mechanical skills, it is still possible to do an acceptable job. It is most important to do a great deal of reading. Read every magazine article or book that is available, and search for more. Look for things that are interesting and have a place in your project.
2. *Organization*: Start a folder or note book of schematics, articles, gadgets, and hints and kinks that pertain to receiver design. This folder can be constantly in use, being revised, added to and reviewed, in order to keep it current and alive in your mind.
3. *Design*: This is where you do the sorting. Here all the ideas, schematics, and methods that are obtained are integrated into a block diagram of the future receiver. The objectives here should be a compromise between your desires, and what is available or prac-

tical. Singlemindedness should be avoided. It can happen in engineering projects that a designer will use certain methods just for the sake of using them. An example is the conflict between integrated circuits and individual component circuits. Don't feel that you have to design a project with all integrated circuits when a circuit with ordinary transistors will be acceptable at a lower cost.

4. *Test Equipment and Tools*: In many cases frustration can result from simply a lack of the proper tools. A simple volt-ohm meter is a must, and a vacuum tube voltmeter is handy for measuring voltages without loading the circuit down, but is not an absolute requirement. Perhaps the most important piece of equipment for working with radio frequencies is the grid dip oscillator. The availability of this instrument made this project possible. One of the most difficult problems is detecting *rf* and telling what frequency it is. Also along this line, a signal generator is useful for tuning up and rough calibration. All the various tools for wiring and metal working have been mentioned many times in other articles, but the most used ones deserve mention. In chassis working, an electric drill with a good set of bits up to about ⅜ inch diameter, a nibbler, and a few handy sizes of chassis punches are necessary. For wiring, wire strippers and needle nosed pliers are constantly in use.

The design

Fig. 1 shows the final block diagram of the receiver. Starting from the antenna input, a 7360 beam deflection mixer is used to convert to the 1750 kHz intermediate frequency. There is only one tuned circuit in the input, but the Q of the air wound inductor is high enough to prevent most troublesome images without a Q multiplier. The most significant feature is the low cross modulation distortion, and the disadvantage is the high cost compared to other tube types. This is a very common circuit and can be found in many publications.[1]

The oscillator circuit is taken from the Highflyer[2], and consists of the popular high C colpitts circuit with the other section of the 12AU7 used as a buffer. A little extra care here really makes the difference with respect to stability. The oscillator operates on 5250 kHz to provide an *if* output on 1750 kHz with an input on either 3500 or 7000 kHz. **Fig. 2** shows this circuit.

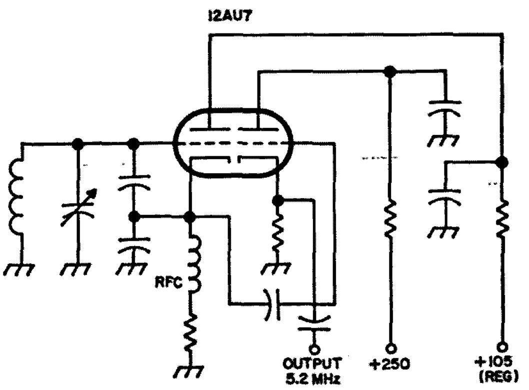

Fig. 2. Schematic of the oscillator circuit.

The second mixer is a necessary evil when a low second *if* is used. It was decided that a pentagrid mixer circuit would be tried in this case, and it was found to be adequate. This was a classical circuit taken from the handbook.[3] It was found that double tuned circuits were necessary in the coupling between the two mixers to reduce image response.

The second conversion oscillator was modified from a circuit in an old handbook,[4] and is a very useful device. A 1000 kHz crystal provides calibration markers, while the plate of the oscillator is tuned to 2000 kHz to provide injection to the second mixer. On the seven MHz frequency the signal from this oscillator is close to the same level as most incoming signals, and provides a handy calibration checkpoint. The schematic is indicated in **Fig. 3.**

Following the mixer is the real reason for the low *if* frequency; the Collins mechanical filter. It was obtained from a friend, and is really the backbone of the receiver. After much experience with crystal filters, it was feared that too high an input level to the filter would harm its frequency response, but even with one volt across the input the response curve is unchanged. The two *if* amplifiers were taken from the handbook[5],

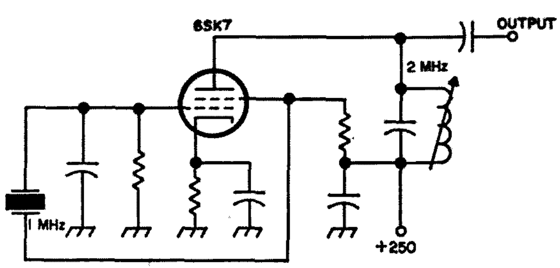

Fig. 3. Second conversion oscillator.

and are completely straightforward. 262 kHz automobile radio *if* transformers were tuned down to 250 kHz with no modification. The *if* transformers were loaded with 10 K resistors across their windings to prevent oscillation when necessary. Expect the *if* amplifiers to oscillate, and take steps to prevent it when they do. The circuits can be detuned or loaded down to reduce the Q without worrying because the selectivity is determined by the mechanical filter at the input. Don't reduce the voltages to stop oscillation, but run the tubes at the recommended voltages for best results.

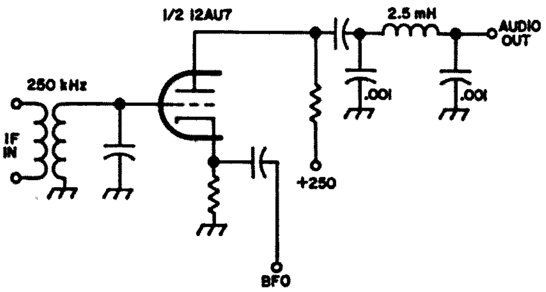

Fig. 4. Simple product detector circuit.

There are many types of product detector circuits which can be used, and **Fig. 4** shows the simplest. The dual diode configuration was tried with less than the best of results. The reverse resistance of the diodes is critical, and it will not work well with just any type diode. The distortion that resulted may have been caused by too low an injection voltage from the BFO, but finally the circuit shown in **Fig. 5** was used. This is similar to a circuit that has been used by Heathkit, and is not much more complicated than the diode circuit. The signal from the BFO is injected into the cathode, the *if* signal goes in at the grid, and audio comes out at the plate. This will handle the strongest of signals without distortion. It is unfortunate that the BFO had to be on the same frequency as the major *if* amplification. If the BFO signal gets around to the input of the *if* amplifier it can ride on through and reduce the effectiveness of the amplifiers. The ideal solution to this problem is using another conversion and putting the BFO and product detector on another frequency. In this case, another conversion would not have been desirable, and careful isolation of the BFO from the first *if* stage is the only recourse. The BFO is a typical circuit$_6$, and a schematic is shown in **Fig. 6**. The only major requirements that this circuit must meet are frequency stability and high output voltage. The output obtained from the 6SN7 was adequate, but the frequency tends to "pull", or change frequency when a strong signal comes through the *if*. This is a major problem in all mixer-oscillator circuits, and the solution is to isolate the mixer, or in this case the product detector from the oscillator. This pulling only results from very strong signals, and has not been a problem except when deliberately driven by a signal generator. This has not been a problem, but if it were, the other section of the 6SN7 is available to use as a cathode follower to isolate the BFO from the product detector as was done in the first mixer.

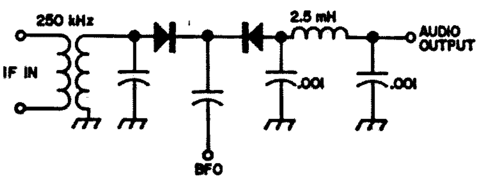

Fig. 5. Product detector circuit chosen for this receiver.

An automatic gain control (AGC) is usually included in modern receivers to allow the receiver to run at maximum gain without being overloaded by a sudden strong signal. The AGC circuit used in this project is a popular one$_7$ that sees a great deal of use in home constructed receivers because of its simplicity and reliability. The audio voltage from the product detector is amplified, rectified, and applied to the grids of the *if* amplifier tubes with a negative polarity. R and C in the circuit determine the duration of the hold-in time between the instant that a signal is removed and the instant that the AGC voltage returns to its no-signal value. The higher the product of R times C, the longer the delay will be. Longer time delays are usually provided for SSB operation, while shorter delays are usually desired for CW operation. Typical values for R and C are 5.6 megohms and 0.1 microfarads. A schematic of this circuit is shown in **Fig. 7**. There are more complicated circuits that are available, but this one will usually prove very successful for a beginner.

One unusual problem that occurred in the AGC area was finally found to be caused by inadequate filtering in the output of the product detector. The strong BFO signal was going through the product detector just like an amplifier and was appearing at the AGC amplifier to produce a high AGC voltage that refused to change value.

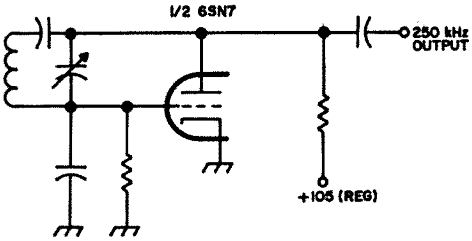

Fig. 6. BFO circuit.

Note the filtering circuit that is used in the plate of the product detector with the *rf* choke and the two .001 microfarad bypass capacitors. Increased filtering is necessary at lower frequencies.

The audio amplifier consists of a 12AX7 driving a 6AQ5 output tube. This is a simple circuit and can be found in many different versions in many publications. Unfortunately, the simplicity can be deceptive, because in this case the audio amplifier caused a great deal of trouble that was attributed to other circuits, thus increasing the problem. The low level voltage amplification stages (12AX7) should be isolated from each other, and from the 6AQ5 to prevent feedback. This can be simply done by adding a resistor (47K is typical) in series between the 12AX7 plate circuit and the power supply, and bypassing it at the plate resistor end with a ten or twenty microfarad electrolytic capacitor. This is almost always included in modulator circuits, but is seldom used in receivers. This precaution was found to be quite necessary in this case. Also, all the ordinary precautions should be observed of shielding the low level audio leads that go to the volume control and the grids of the voltage amplifiers. Power leads should be placed so that they are away from these sensitive leads.

Last and usually least discussed, is the power supply. The power supplies today are usually built with solid state rectifiers, and this receiver is no exception. The problem encountered here was the assumption that a small transformer could be used if some of the tube filaments were on the 5.0 volt winding of the power transformer. In this case, this resulted in a degradation of the overall sensitivity of the receiver, and caused months of frustrated *if* amplifier building and modification where none was needed. This is a case where a good VOM applied to the right place can help a great deal. In a last effort, the tubes were checked in a tube tester, and, by chance, one was replaced in the receiver while the filament was still hot. What a difference! The transformer found its way to the trash can in the same evening.

Mechanical layout and construction

In starting a project of this magnitude it is usually a good idea to invest a considerable amount of money to provide a proper foundation for the receiver. A one-eighth inch thick aluminum rack panel was purchased as was a chassis and side braces. These components along with the dial make up the major cost of the receiver. The chassis was selected as large as possible, and was still too small after several additions were made. Also, a collection of smaller chassis would provide better shielding between circuits and better mechanical rigidity but it is very difficult to work down inside the small spaces. The best Eddystone dial was selected to provide a smooth and mechanically stable frequency control. The price is reasonable when the results are considered, and can be justified by noting the feelings that can be involved when working with a project of this magnitude. There is also a great incentive involved when a considerable amount of money has been spent, and using cheaper components can result in discouragement.

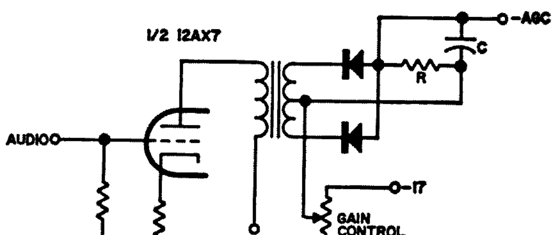

Fig. 7. The AGC circuit.

The objective here is to arrange the components so that they physically resemble the block diagram. This is to provide isolation between circuits that when coupled may cause annoying feedback, and to provide close coupling between circuits that are connected to each other. Also, the mounting of the first oscillator circuit is considered, and all possible methods should be employed to provide a solid mechanical mounting of this unit. The oscillator is usually constructed in a separate box to provide thermal insulation with the ambient temperature to pre-

vent temperature changes from affecting the frequency. This was considered in this case, and it is also important that the tube is mounted outside of the box. The oscillator compartment was mounted on a three-eighth inch thick aluminum slab and mounted with one quarter inch diameter brass bolts through spacers to align the oscillator variable capacitor with the dial shaft. A semi-flexible coupling taken from an old surplus tuning unit was used to prevent binding in the case of any misalignment. The large metal base was used only in the hopes that increasing the mass of the unit would make it more resistant to mechanical shocks. The chassis is depended upon to provide most of the coupling between the box and the dial. An improvement here with the addition of more bracing between the oscillator box and the dial would be a needed improvement if the unit were to be subjected to a great deal of vibration in operation. At this point, as a reminder, it is always good to use lock washers in all construction. The bolts that hold the panel to the chassis have a habit of working out if the unit is moved around.

The only comment about wiring is: be patient. Wiring can get quite messy in experimental work during the excitement of the chase, and should be gone over after final decisions have been made. Also, when wiring it is always a good idea to start from the output and work forward. This is done to prevent frustration that can result when a large device is built with the inevitable errors which are always present, only to find a massive trouble shooting project when it was thought the project was completed. Each circuit was constructed so it could be checked in operation before going on to another circuit. Building a huge receiver seems like quite a large project, but no one will balk at building just a power supply, or just an audio amplifier, or some other individual circuit. The success of each step will add encouragement, and success is not difficult in any given unit.

A few words concerning parts substitution are in order here. A well stocked junk box can be a great asset, but it can cause a good deal of grief if used excessively or unwisely. It must be established without any doubt that a component to be employed is usable for the intended application. A component that is faulty and is assumed to be good can cause one to suspect some component that is not the cause of the problem. For example, the variable capacitor used in the first oscillator was taken from a surplus ARC-5 command transmitter. Here was the ideal capacitor with ball bearings at both ends of the rotor shaft, and very rugged, stable construction. However, the contact between the rotor and ground was corroded, and caused an uneven change in frequency as the dial was turned. A great deal of effort and worry was involved in trying to cure the "backlash in the dial." The main point is just to avoid using components which are not new or in new condition, and it doesn't make much sense to build a new receiver with components which are not new. It is also a good idea to buy small components such as resistors and capacitors new, rather than using old ones. The old leads which have been bent can break, and sometimes a distributor will give a discount when large quantities are purchased as would be true when building a receiver.

Results

The sensitivity was measured with a TS 413 A/U signal generator. The *rf* voltage was applied to a fifty ohm carbon resistor across the input at 7200 kHz. With the output on the ten microvolt scale, the receiver could still give Q5 copy on the generator output with the output level control at zero. This was probably less than one half microvolt, which was the least scale count on the output level meter of the signal generator.

The stability was good. In a test where the first oscillator was zero beat with WWV (on 5 MHz) the power had been on only long enough for the filaments to come up to operating temperature. During this one half hour test period, the signal stayed zero beat as far as could be detected, and the drift must have been less than 100 Hz. In actual operation, warm up drift is never noticed. In a condition like amateur operation, short term stability is the prime consideration rather that how much drift there has been after two days. Since transmissions and QSO's are usually short, it is the stability during a short period of time that is most important. Dropping the receiver can cause a frequency change of a few hundred Hertz, depending on the height from which it is dropped. This is mostly due to the dial changing, and not being rigidly referenced to the tuning capacitor. However, in normal operation, the receiver

is seldom dropped, and is of no great consequence.

Just indicating that a mechanical filter is used is sufficient to determine the degree of selectivity. The selectivity is adequate in all respects, indicating that care had been taken to isolate the input of *if* amplifier to signals that might have sneaked around the filter. Image response is not so commendable, and a few weak images from strong navy teletype stations near this location can be heard. This is a result of the multiple conversions also multiplying the chances for images. This has not caused any problems when the receiver is used with a well tuned antenna, but for weak signal reception with a poor antenna close to a strong transmitter, problems could result. There are plans for increasing the selectivity for CW by the addition of toroid coil audio filters. Also the bandpass can be widened by adding capacitors across the mechanical filter if the receiver is to be used for AM.

Afterthoughts

Since this receiver covers only eighty and forty meters, crystal controlled converters are planned for the higher frequency bands. The good cross modulation characteristics of field effect transistors with their low cost (less than one dollar), their simplicity (only three leads; no filament or screen), and compact size make them ideal to meet the requirements of this receiver. The now widely available information on them[8] will make this an easy addition, and mechanical layout will be the only chore.

In conclusion, considering the money and effort that went into this project, it has given a very good return, not just considering the performance of the receiver, but the experience which has been gained from the errors and corrections leading to the final success.

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3-Tube Superhet Short-Wave Receiver

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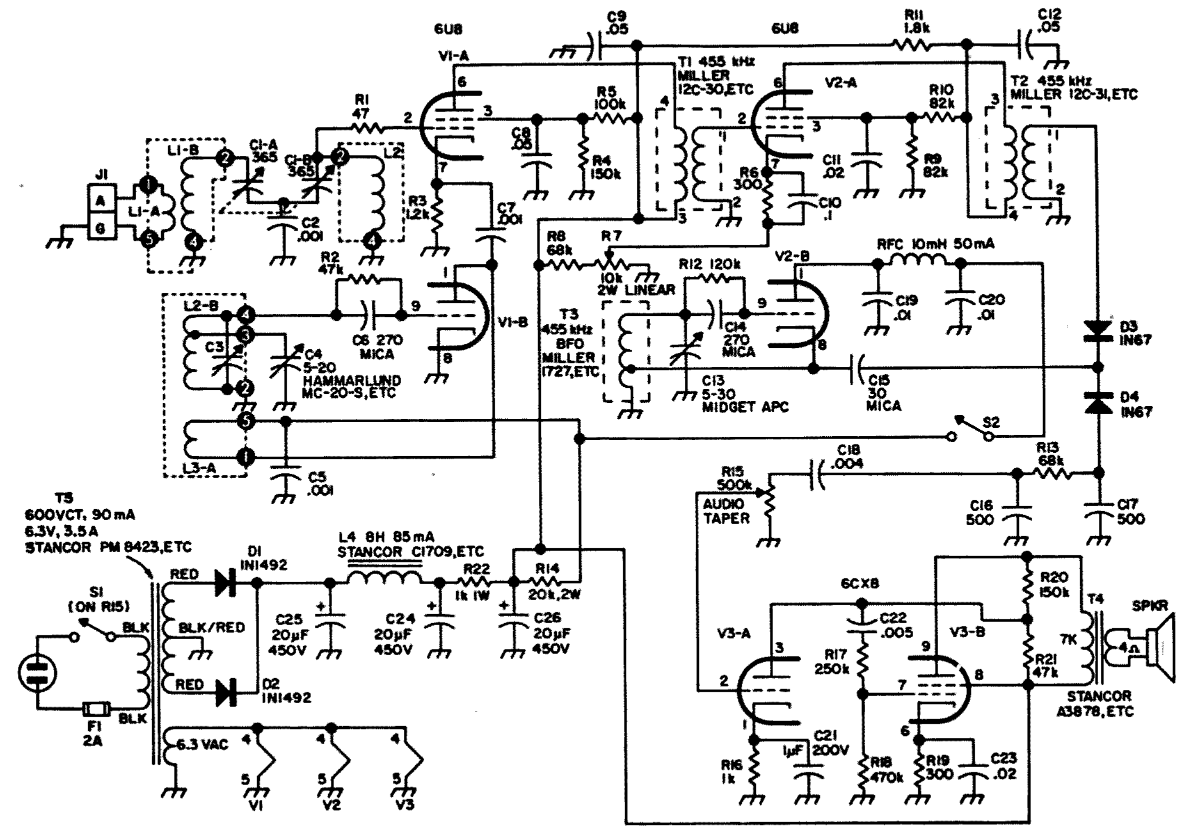


Fig. 1. Complete schematic for the 3 tube superhet receiver.

Here's a 3-tube package of electronic dynamite that carries as big a wallop as many short-wave receivers costing three times as much. It is simple enough for a beginner to construct, performs well enough to please an old timer, uses readily available parts throughout, and cost less than fifty dollars to build—and even this amount can be reduced by half if you cannibalize an old broadcast set for some of the parts!

True this receiver doesn't have all the fancy bandswitching found in larger, more expensive sets, but it *does* have all necessary circuitry for code and single sideband reception—plus plenty of gain, and loudspeaker output. Its very simplicity is one of its salient features. For here is a receiver which can be modified, added to on the front end, its coils and tuned circuits changed and experimented with; all resulting in a lot of fun and self-satisfaction, while at the same time giving its builder valuable experience and confidence without pressing too hard on his pocketbook.

Experience gained from building this receiver will allow the ham to work on his own communications receiver without "fear of messing up a piece of expensive equipment," as is so often heard. You may want to make an improved or modified version, but a note here: The receiver, exactly as shown, will give a good account of itself, and is a project well worth undertaking.

The "dynamiter" employs plug-in coils and one-dial tuning to cover the 80 and 40-meter amateur radio bands. And with a little ex-

perimenting (and some sacrifice in performance), coils for the 20-meter, 15-meter, and 10-meter bands can conceivably be wound.

About the circuit

Essentially, the "dynamiter" is a 2-stage superhet using three dual-purpose tubes to deliver 6-tube performance. (See **Fig. 1.**) It employs a converter, an *if* amplifier, a product detector, a beat frequency oscillator, and two stages of audio amplification.

Signals from the antenna are fed to the mixer, the pentode section of VI (6U8), through coil LI and coil L2, which are tuned by the dual-section broadcast capacitor CI. This adds selectivity and the capacitor is large enough to all two-band coverage without changing coils LI or L2, simply by retuning.

The triode section of VI serves as the local oscillator. The oscillator coil L3 is tuned 455 kHz below the incoming signal with padding capacitor C4, mounted inside the coilform. Main tuning (of the local oscillator) is by the large vernier dial centered on the front panel, and which is attached to the small bandspread variable capacitor C3.

After the signal is hetrodyned to 455 kHz in the mixer, it is fed to the pentode section of V2 (6U8), which functions as an *if* amplifier. The amplified signal is then applied to the product detector formed of the two IN67 diodes D3 and D4. The triode section of V2 serves as a Beat Frequency Oscillator, and a signal from this oscillator is capacity coupled through C15 to the product detector for carrier re-insertion of sideband signal or to produce a beat note with CW signals. AM signals may be received by tuning them in and zero-beating the bfo. The detected signal is amplified by V3 (6CX8) to a level sufficient to drive the loudspeaker, the triode section of V3 serving as the first audio amplifier and the pentode section as the second.

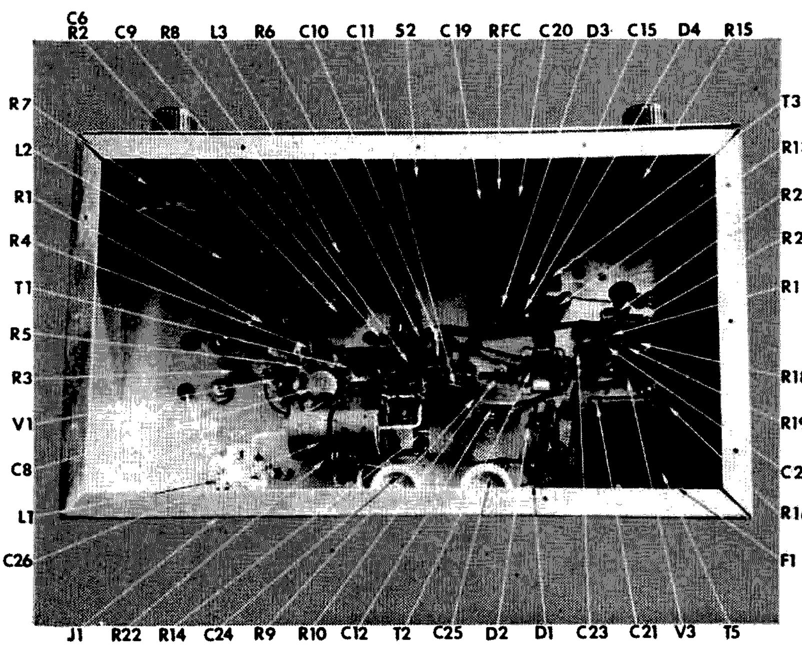
Full-wave rectified B+ is furnished by the power supply, comprised of power transformer T5, two (IN1492) silicone diodes D1 and D2, the smoothing choke L4, and filter capacitors C24 and C25.

Construction

The receiver is assembled on a 7 x 12 x 3 inch aluminum chassis. (Fig. 2.) The speaker and operating controls are mounted on a front panel 7¼ inches high and 12 inches wide, cut from scrap aluminum sheetmetal. The case is also fashioned from scrap aluminum sheetmetal.

Mounting dimensions, coil and tube hole sizes are shown in Fig. 2. And while these will vary with individual construction (depending upon the size of the speaker, output transformer, and power transformer used), adhering to the general layout shown will result in over-all symmetry, making for a neat job. Drill sizes are not given, as these also will vary. All screws that protrude the front panel are countersunk.

The bandspread tuning capacitor C4 and



Parts layout for the Dynamiter receiver.

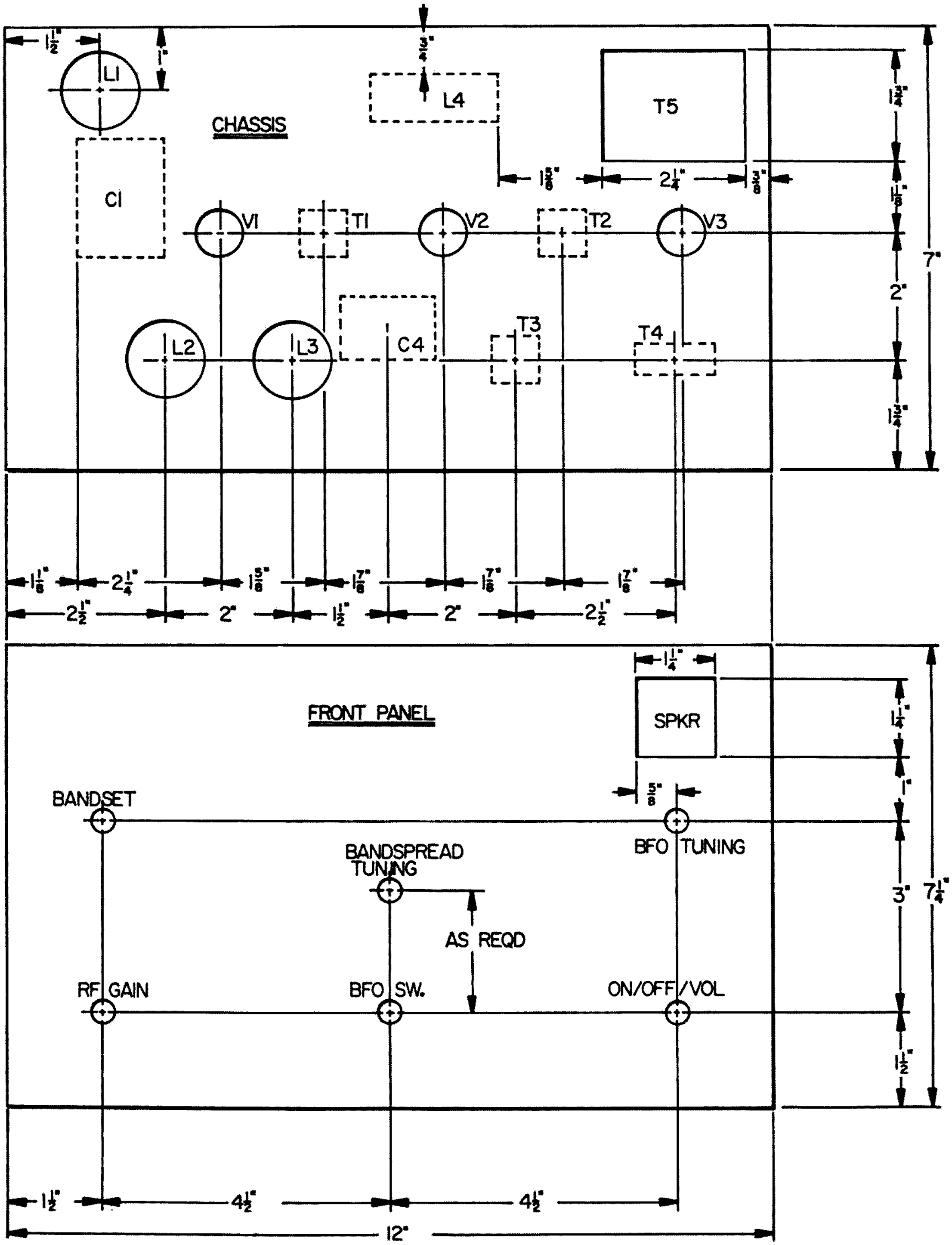


Fig. 2. Mounting dimensions, hole sizes and general chassis layout.

the dial assembly should be mounted first. The capacitor is centered on the chassis, and the dial aligned on the front panel to match the capacitor shaft. (The front panel may be attached temporarily to the chassis with four #6 countersunk screws placed ½ inch from each chassis corner.) After the main tuning capacitor and dial are mounted, mount power transformer T5. Order of mounting is important because the rest of the layout hinges around these components.

This accomplished, mount the speaker, the output transformer, and bfo coil next, as the size of the speaker and output transformer

may vary. You may then juggle the remaining components to be mounted on the topside of the chassis as desired; maintaining as closely as possible the symmetrical layout shown.

Coil Data

Coilforms are 1¼-inch diameter polystyrene 5-pin plug-in (Amphenol 24-5P). Coils L1A, L1B, and L2 are cut from B&W 3016 Miniductor and fitted down inside coilforms. Coil L1A is 8 turns and coil L1B and L2 are 19 turns. Count off 30½ turns, clip at 9 turns, and use ½ turn for leads, leaving L1A and L1B on same piece of stock and separated by 1 turn. Coil L3 is wound with #26 enamel wire. All coil windings are in the same direction. For 80-meter reception, coil L3A is 12 turns close wound. Coil L3B (separated from L3A by ⅜ inch) is 30 turns close wound, then 4 turns space wound over ¼ inch, then 5 turns close wound, tapped at 32½ turns. C3 is 75 pF. For 40-meter reception, coil L3A is 10 turns close wound. Coil L3B (separated from L3A by ¼ inch) is 7 turns close wound, then 17 turns spaced over 1 inch, tapped at 10 turns. C3 is 50 pF.

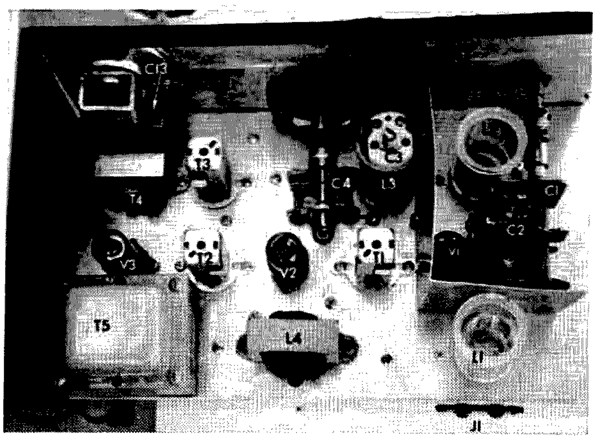
The shield separating the coils, and the shield around the bfo tuning capacitor (also cut from 1/16 inch thick aluminum scrap and mounted with spade lugs) are a must. They permit required electrical separation of the circuits.

The remaining construction is not too critical. However, liberal use of terminal strips for mounting of the components underneath the chassis is recommended. So is the use of fairly stiff (#20) hook-up wire. These help prevent the receiver from becoming mircophonic. All wiring except power supply wiring should, as much as possible, be point-to-point, and leads kept short.

After the receiver is completed and playing, the front panel may be masked off, spray painted, and dressed up with decals or transfer lettering. The enclosure (if one is used) may be removed and painted. And the dial, once calibrated, also may be marked with transfer numbers.

Adjustment

Although it is possible to align the receiver without the use of an rf signal generator, it is a job for an experienced serviceman or an oldtimer, and takes some time and doing. So if you don't own such an instrument, beg,



Top view showing parts layout

badger, or blackmail a friend into the loan of one. The job without it is almost a hopeless chore.

Start adjustment by setting the generator to deliver an audio signal. Connect the "hot" lead of the generator to the end of R13 (68K) that feeds the audio. Advancing the volume control should produce a loud signal through the speaker.

Next, place the bfo switch to OFF, feed a 455 kHz modulated signal to the grid (pin 2) of V2. Tune *If* transformer T2 slugs for the loudest signal. *If* transformer T1 is tuned by removing oscillator coil L3, and coupling generator lead (thru a blocking capacitor) to the plate (pin 6) of V1. (Caution: B+ voltage is present at pin 6 of V1.) It will be necessary to adjust rf gain pot R7 for optimum results.

To adjust the BFO coil T3, leave the generator connected to pin 6 of V1. Set generator to an unmodulated output and the bfo tuning capacitor C13 half meshed. Adjust bfo coil slug for zero beat. (Zero beat is determined by finding the "valley" of two loud whistles just each side of 455 kHz.)

To tune the front end, set the generator for 3.8 MHz modulated output. Connect generator leads to antenna terminals J1 and plug in the 80-meter coil L3. Set bandset capacitor C1 to about three-fourths (approximately number 8 on the knob). Set bandspread capacitor C4 to full mesh and advance volume to full gain. Turn up the rf gain to about three-fourths maximum and tune capacitor C3 (inside coil L3) for maximum signal output. It may be necessary to re-touch the slugs at transformers T1 and T2). The oscillator coil for 40-meter operation may be tuned in the same manner. Once an oscillator coil has been set, it may

PARTS LIST

C1A, C1B—365 pF, dual variable capacitor
C2, C5, C7—0.001 μF, 600-volt ceramic disc capacitor
C4—5-20 pF variable capacitor (Hammarlund MC-20-S or equivalent
C3—Midget "APC" variable capacitor (See Fig. 4)
C6, C14—270 pF, 400-volt mica capacitor
C8, C9, C12—0.05 μF, 600-volt ceramic capacitor
C10,—0.1, 200-volt ceramic disc capacitor
C11, C23—0.02 μF, 400-volt ceramic disc capacitor
C13—35 pF midget "APC" variable capacitor
C15—30 pF, 400-volt mica capacitor
C16, C17—500 pF, 150-volt ceramic disc capacitor
C18—0.004μF, 200-volt ceramic disc capacitor
C19, C20—0.01μF 400-volt ceramic disc capacitor
C21—1.0μF, 200-volt paper capacitor
C22—0.005μF, 400-volt ceramic disc capacitor
C24, C25, C26—20μFD, 450-volt electrolytic capacitor
D1, D2—1N1492 diode
D3, D4—1N67 diode
F1—2-ampere fuse (and fuse holder)
J1—Antenna terminal
L1—Antenna Coil, B & W 3016 Miniductor coil
L2—B & W 3016 Miniductor coil
L3—Oscillator coil (See Fig. 4)
R1—47-ohm, ½-watt resistor
R2, R21—47,000-ohm, ½-watt resistor
R3—1.2K ohm, ½-watt resistor
R4, R20—150,000-ohm, ½-watt resistor
R5—100,000-ohm, ½-watt resistor
R6, R19—300-ohm, ½-watt resistor
R7—10,000-ohm, 2-watt potentiometer, linear taper
R8, R13—68,000-ohm, ½-watt resistor
R9, R10—82,000-ohm, ½-watt resistor
R11—1800-ohm, ½-watt resistor
R12—120,000-ohm, ½-watt resistor
R14—20,000-ohm, 2-watt resistor
R15—500,000-ohm potentiometer audio taper
R16—1000-ohm, ½-watt resistor
R17—250,000-ohm, ½-watt resistor
R18—470,000-ohm, ½-watt resistor
R22—1K 1W resistor
RFC—10 millihenry, 50 mA, radio frequency choke
S1—S.p.s.t switch (on R15)
S2—S.p.d.t. miniature toggle switch
T1—455 kHz intermediate frequency transformer (J. W. Miller 12C-30 or equivalent)
L4*—8-Henry, 50 mA filter choke (Stancor C1709 or equivalent)
T2—455 kHz intermediate frequency transformer (J. W. Miller 12C-31 or equivalent)
T3—455 kHz beat frequency oscillator transformer (J. W. Miller 1727 or equivalent)
T4—Output transformer: primary 7000 ohms; secondary, 4 ohms (Stancor A3878 or equivalent)
T5—Power transformer, 600 VCT @ 90 mA and 6.3 volts @ 3.5 amperes (Stancor PM 8423 or equivalent)
V1, V2—6U8 tube
V3—6CX8 tube
Spkr—3", 3.2-ohm speaker
Chassis—7" x 12" x 3" aluminum
Coil Form—1¼", 5-pin (Amphenol 24-5P; available from Allied Radio, Chicago, Ill.
Misc.—Knobs, a.c. line cord, 9-pin tube socket, 5-pin coil socket, terminal strips, hook-up wire, hardware, 1/16" thick aluminum scrap, etc.

be plugged in and out of the circuit without re-setting.

Operation

Connect a good antenna system (aerial and ground both) to antenna terminal J1, and turn the receiver on. Set the rf gain control all the way up. Advance volume control until a loud oscillation or noise is heard.

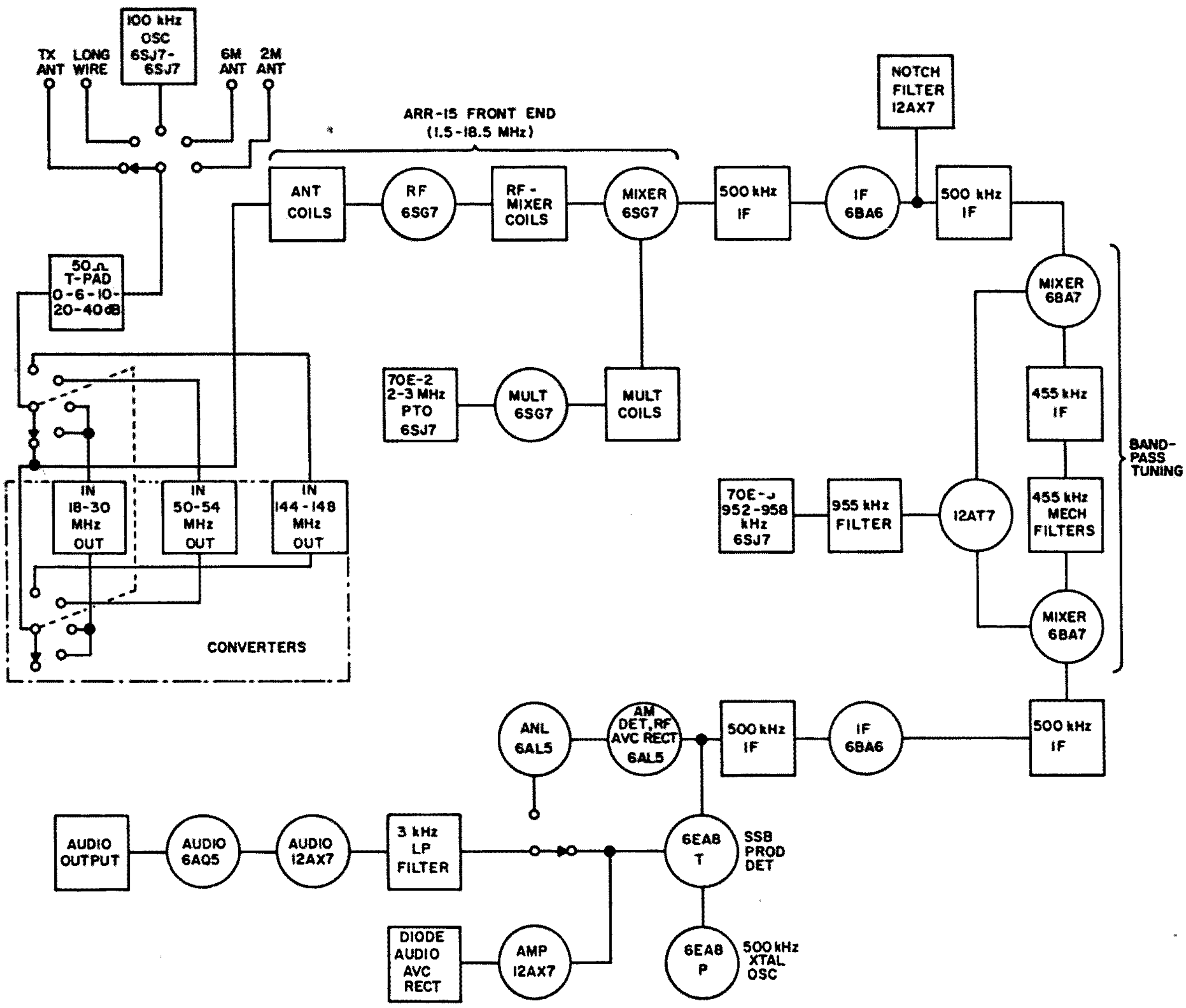
Then back off on the rf gain to just below the point of oscillation. Manipulate the bandspread tuning dial. The stations should come booming in! If the station being received is a CW or an SSB station, adjust bfo tuning knob for best results.

Perhaps it should be pointed out here that this receiver is not the ultimate in selectivity like the numerous expensive, but good, receivers found on today's market. The "dynamiter" was not designed to be used as the sole receiver in the ham shack. However, it *can* and *will* do creditable standby for such a purpose in case of an emergency. Also remember the ham bands are overly crowded these days.

But with a little practice and experience, you will soon be listening to the ringing *dit-dahs* of CW, or to the hopeful voice of the ham calling, "CQ, DX! CQ, DX!," on your 3-tube package of electronic dynamite.

. . . W6ELJ

"Now you're in a helluva QTH"



The MO* Receiver

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Introduction

Through the years since becoming interested in radio, the author has built and modified many communications receivers; all the way from crystal sets to multi-tubers-(no transistors). The purpose of each new receiver project was, of course, to incorporate new techniques and ideas in an effort to improve reception. Many articles and discussions have been presented in the amateur journals covering a multitude of improvements to old receivers, construction of new receivers and some suggested ideas requiring further development. This article describes a receiver design based on the employment of a portion of a surplus airborne communications receiver.

* Midnight Oil

This is not a step by step "nut and bolt" type article; but rather, a description of a receiver that was constructed from junk parts from old equipments.

It was prepared in the hope that it might encourage others to attempt more home construction projects. It obviously requires access to some machinery, test equipment and not just a little time. The satisfaction of building and enjoying homebrew equipment far outweighs that of being an appliance operator (in the authors opinion).

Following are the features which were considered desirable to be included in the receiver:

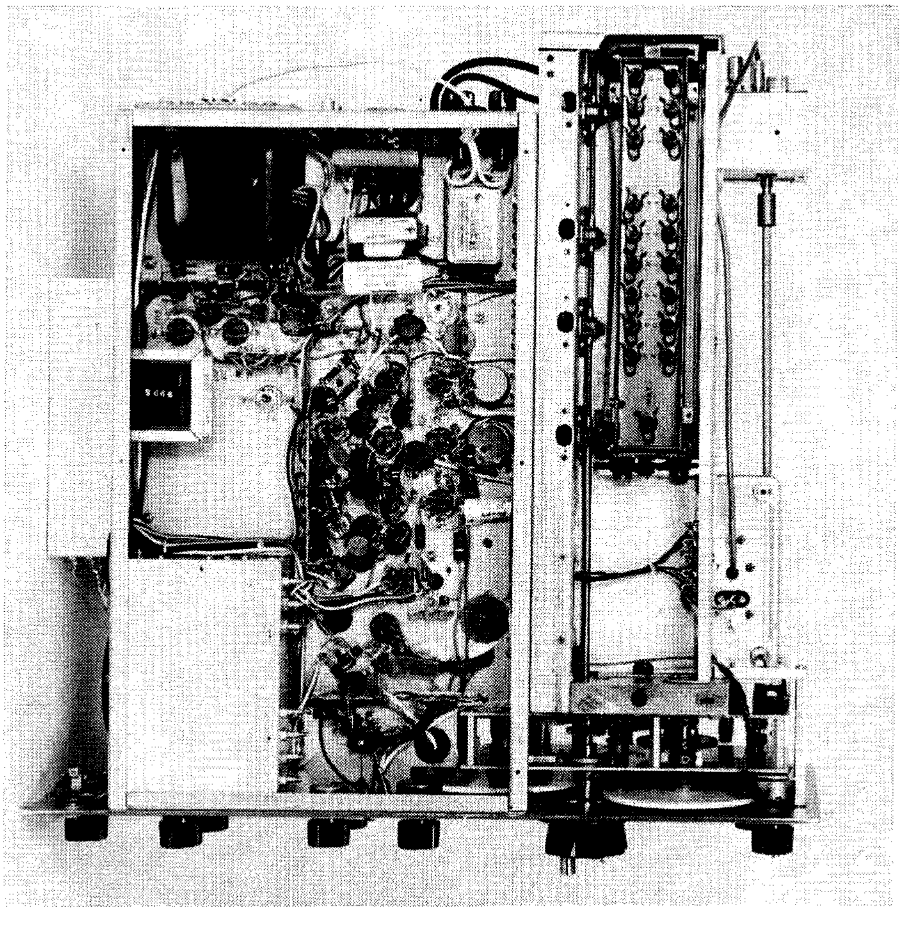
1. Continuous coverage from 2 MHz to 30 MHz with crystal controlled converters for 6 and 2 meters.
2. One kHz calibration accuracy throughout the 2-30 MHz range of the receiver (when calibrated at closest 100 kHz point)
3. Stability-for good SSB reception.
4. Several degrees of *if* selectivity.
5. Band pass tuning.
6. RF or Audio operated avc.
7. Tunable (across *if*) notch filter.
8. Antenna input T pads (0-40db).
9. Good front end design to minimize cross modulation and result in reasonable sensitivity.
10. Separate *rf*, *if*, and audio gain controls.
11. Other routine features such as S meter, ANL, Audio low pass filter, AM and SSB detectors, 4 and 600Ω audio output, etc.

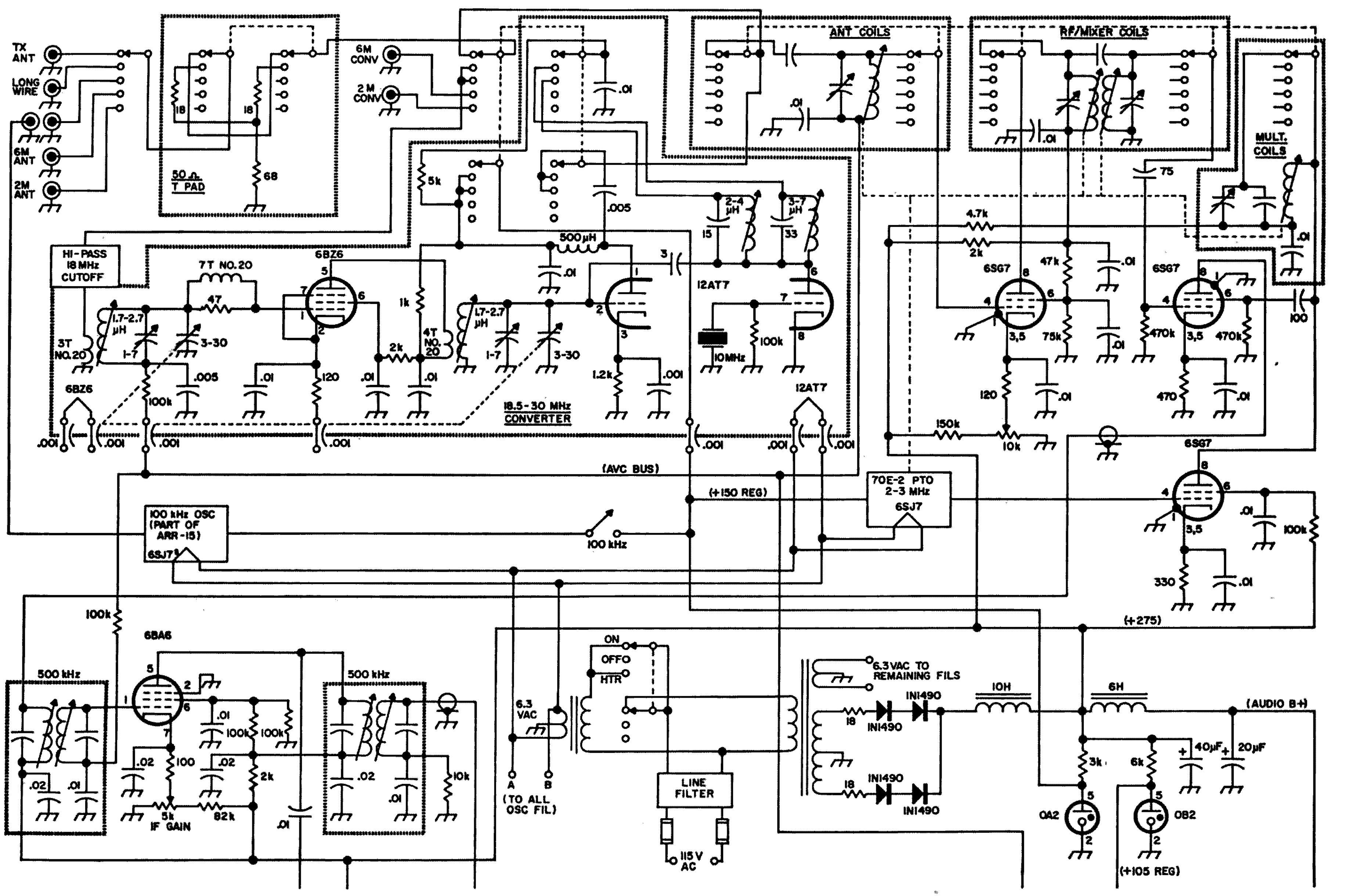
AAR-15

The AAR-15 is an airborne tunable HF communication receiver with provision for remotely controlling a given number of preset frequencies. It covers the frequency range of 1.5 to 18.5 MHz in six bands as follows: 1.5-2.5, 2.5-3.5, 3.5-5.5, 5.5-8.5, 8.5-12.5 and 12.5-18.5. The *if* is centered on 500 kHz and is tunable from 40 kHz to 550 kHz. Both, the first mixer injection frequency oscillator and the *if* tunable bfo oscillator are of the Collins PTO type. The receiver uses a 12SG7 rf, a 12SG7 mixer, and a 12SG7 tuned multiplier to multiply the PTO basic frequency of 2 to 3 MHz up to the desired injection frequency for the various bands. It is only the rf, mixer, PTO and PTO multiplier that are of interest to this project. The rf, mixer, PTO and PTO multiplier tuned circuits are all mechanically ganged together through gears and shafts which drive the slug rack to tune the coils of the various circuits.

The front end of the receiver was checked for tracking, calibration and sensitivity before it was decided that it would merit becoming the basis for building the receiver. The AAR-15 used on this project had been junked out as it had seen much "maintenance" and modifications—fortunately the front end was in fairly good condition.

Bottom View





TX ANT
LONG WIRE
6M ANT
2M ANT
50 Ω T PAD
6M CONV
2M CONV
ANT COILS
RF/MIXER COILS
MULT. COILS
HI-PASS 18 MHz CUTOFF
7T NO.20
6BZ6
3T NO.20
1.7-2.7 μH
4T NO. 20
500μH
12AT7
10MHz
18.5-30 MHz CONVERTER
(AVC BUS)
(+150 REG)
70E-2 PTO 2-3 MHz 6SJ7
100 kHz OSC (PART OF ARR-15) 6SJ7
100 kHz
6SG7
(+275)
6BA6
500 kHz
5k IF GAIN
6.3 VAC
(TO ALL OSC FIL)
ON
OFF
HTR
LINE FILTER
115 V AC
6.3VAC TO REMAINING FILS
1N1490
10H
6H
(AUDIO B+)
OA2
OB2
(+105 REG)

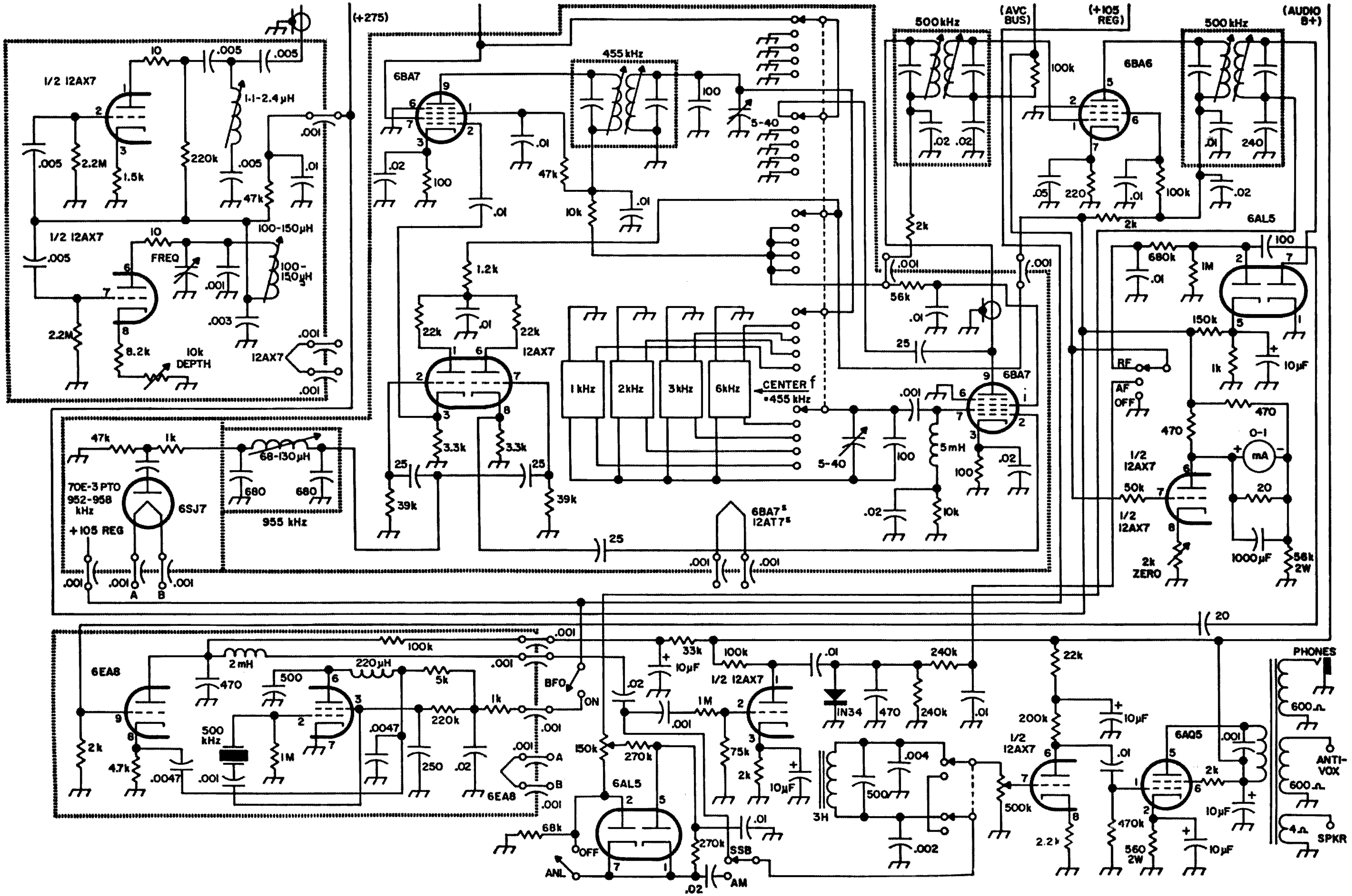


Fig. 2. The complete schematic diagram.

Circuits

Fig. 1 is the block diagram of the receiver. **Fig. 2** shows the complete schematic with the rf, mixer and multiplier circuits. The only uncommon circuit is the band pass tuning arrangement. This idea was described in one of the amateur journals some years ago.

Antenna input is selected by a wafer switch. A 0-6-10-20-40 db 50 ohm T pad, is in the antenna circuit to provide attenuation to help reduce cross modulation when strong local signals are encountered. The ganged wafer switch selects the desired converter or connects the antenna directly to the 1.5-18.5 MHz basic receiver.

The basic 1.5-18.5 MHz receiver covers the frequencies in the following manner:

Band	Recvd Freq.	PTO Freq.	Mixer Inj. Freq.
A	1.5- 2.5	2-3	2-3
B	2.5- 3.5	2-3	2-3
C	3.5- 5.5	2-3(x2)	4-6
D	5.5- 8.5	2-3(x3)	6-9
E	8.5-12.5	2-3(x4-	8-12
F	12.5-18.5	2-3(x6-	12.18

The basic frequency range is extended to 30 MHz by a converter in the following manner:

Recvd Freq.	Recvr Band	Conv OSC Freq.	Inj. Freq.
18.5-22.5	E(8.5-12.5)	10	10
22.5-28.5	F(12.5-18.5)	10	10
28.5-30.0	E(8.5-10.0)	10(x2)	20

This arrangement provides for having the dial indicating the correct frequency after mentally adding the 10 or 20 MHz as required. The converter preselector tunes rather sharply and must be peaked at the selected frequency.

Output from the 1.5-18.5 MHz section is amplified at 500 kHz and fed to the band pass tuning section. The 500 kHz signal is converted to 455 kHz by a PTO tunable 952 to 958 kHz; with the same PTO frequency converting the 455 kHz signal back to the original 500 kHz frequency-*after* the *if* signal has been processed through the mechanical filters. Any one of several bandwidths may be selected or the band pass tuning and filters may be by-passed entirely for broadband AM type reception.

The signal from the band pass tuning circuit is then amplified again at 500 kHz and fed to a conventional AM diode detector and a SSB product defector. A crystal oscillator is employed for the bfo injection frequency to the product detector. AM and SSB Audio may be processed through a 3 kHz low pass filter if desired. Audio from the product detector is amplified and rectified by a diode and then filtered to provide the audio operated avc voltage. 4 and 600 ohm audio outputs are provided by the output transformer.

A separate *rf* gain control was provided for the converters. The *if* stages were also provided with a separate gain control.

The AVC voltage is applied to the *rf* stage (both basic and in the converters) and to the 500 kHz *if*'s.

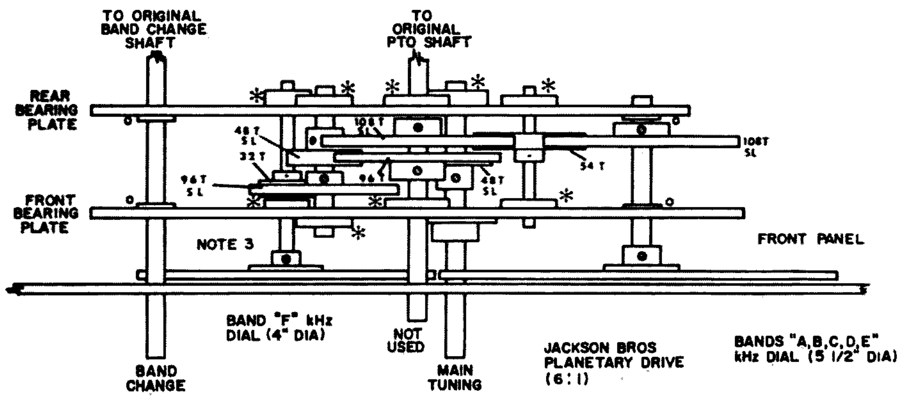
The power supply is conventional with solid state rectifiers and plenty of filter. Provision was made for being able to keep the oscillator filaments on separate from the other filaments if desired.

Construction

The first major step in the construction of the receiver was to amputate the desired section of the ARR-15 from the rest of the machine. All of the autotune drive mechanism, dials, front panel tubes, etc. were first removed. A hack saw was then used to saw the cast aluminum base in two; leaving the *rf*, mixer, multiplier and PTO intact with their slug rack tuning mechanism still coupled to the PTO tuning shaft.

A new aluminum chassis was selected on which to mount the new *if*, audio, and power supply. The front panel is a nominal 8¾ inches high by 19 inches wide standard rack size panel.

The second major step was the design and construction of two new dials and a new gear train mechanism to drive the new dials. See **Fig. 3** for a sketch of the new gear train. The original MHz dial coupled to the PTO shaft was retained and provides the MHz indication. The two new dials provide 1 kHz readout on all bands with the second dial (F) being added in order to provide larger calibration divisions on Band F where the PTO frequency is multiplied six times. Thus, one dial is read on Bands A, B, C, D, and E: and the other dial on Band F only.



Gear train and drive dial assembly.

TOP VIEW

NOTES:

1. SHAFT THRUST COLLARS NOT SHOWN
2. BEARING PLATE SPACERS NOT SHOWN
3. ORIGINAL MHz DIAL & BAND INDICATOR MOUNTED ON FRONT BEARING PLATE A IS NOT SHOWN
4. REAR PLATE MOUNTED TO ARR-15 CASTING
5. * = BALL BEARING
   O = OILITE BEARING
   SL = SPRING LOADED

The gear train was built up using two ⅛ inch aluminum plates between which all of the gears and couplings were mounted. Spring loaded gears were used where needed which resulted in no backlash. Practically all gearing shafts run in ball bearings. A Jackson Bros. planetary drive was employed between the gear train and the main tuning knob for additional gearing reduction and smoothness of tuning. The gear train and dial assembly attaches to the front of the ARR-15 aluminum casting at four places and is in no way attached to the front panel. Fiducial markers are installed on each of the two new dials to permit accurate frequency calibration on any band.

The band pass circuitry, except for the 70E-3 PTO, is all mounted in a separate shielded compartment beneath the new chassis with all leads entering the compartment through feedthru capacitors with the exception of the *rf* leads which are of coax. The 70E-3 PTO frequency range was raised from the original nominal of 500 kHz to a nominal 955 kHz by replacing the 1700 pF (N50) capacitor with a 360 pF silver mica. The 955 kHz single pi section tank is mounted in a small aluminum box on top of the PTO with coax carrying the PTO signal to the bandpass tuning mixers. A Jackson Bros. planetary drive is employed between the PTO shaft and the bandpass tuning knob.

The product detector and the crystal oscillator bfo are mounted in an aluminum *if* can with all leads entering thru feedthru capacitors except the *rf* lead from the last *if* transformer.

The 18.5-30, 50-54 and 144-148 MHz converters are mounted on a single enclosed chassis which mounts upright to the right hand side of the main chassis. All leads enter thru feedthru capacitors. Only the 18.5-30 MHz converter has been completed. All of the 50-54 and 144-148 MHz components have been mounted. These two converters will employ 6CW4 tubes in circuits borrowed from the *ARRL Handbook* and will be crystal controlled.

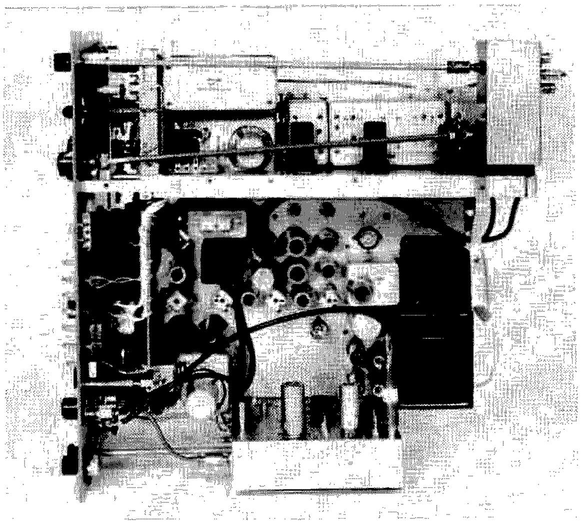
The *rf* mixer and multiplier stages were completely rewired (external of the coil boxes) with disc ceramics being used for the bypass capacitors. The original 12SG7s and 12SJ7s were replaced with the six volt equivalents.

The 500 kHz *if* transformers are nominal 455 kHz transformers that were capable of being tuned to 500 kHz.

The original "cut and try" kHz dials are hand lettered on bond paper and cemented to ⅛ inch thick pressed wood discs. Final dials will be made by photographing an ink lettered vellum and then cementing the negative to an opaque Plexiglas disc; thus permitting back lighting.

Operation

Operation of the receiver has been most satisfactory. Stability is very good after a moderate warm up period. Frequency calibration is well within one kHz when the



Top View

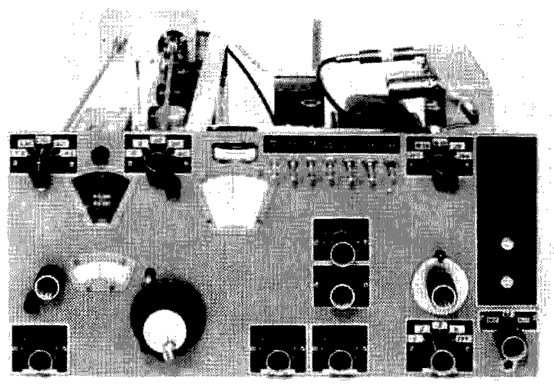
fiducial marker is set to zero at the nearest 100 kHz point. The selectable *if* bandwidth/band pass tuning feature is most rewarding when tuning SSB on the crowded amateur bands. Antenna sensitivity in the SSB mode (for 10 db S/N) is better than - μv from 1.5 to 30 MHz with the average being in order of .5 μv when measured with a GR No. 1000-P2 series pad and a 3 db pad at the receiver input terminal). Both the rf and audio operated avc circuits permit an audio output increase of 6-7 db when the input signal is increased from 5 μv to 100 K μv. The audio operated avc appears to be more desirable when receiving in the SSB mode. Although the Q multiplier notch filter is effective in reducing carrier interference, some other type of tunable notch filter would probably produce better results.

Since considerable effort was spent in parts layout, shielding, by-passing and filtering, few "birdies" have been found. The only one encountered of any consequence is the second harmonic of the 18.5-30.0 MHz converter crystal at 20 MHz. The three section, 50 ohm, 18 MHz cutoff high pass filter at the input to the converter practically eliminates the frequencies below 18.5 MHz from "riding through" the converter. When a 10 M antenna is connected to the converter, no low frequency signals have been heard in the 10 M band. Installing the single pi section right at the output of the band pass tuning 70E-3 PTO eliminated several spurious signals in the lower frequency bands. Care must be taken to prevent the 500 kHz bfo signal from getting into the front end of the *if*.

The tuning meter is plainly a tuning indication and useful only in giving comparative signal reports. It is not calibrated in db over too, if you would like a receiver with all of with an input of 100 K μv at 14 MHz. With the avc characteristics being what they are, a signal level of several μv will give a useful indication on the meter; depending of course, on the ambient noise level.

The band change control rotates a mask in the MHz dial window. This mask indicates the band selected ie, BAND C, 3.5-5.5 MHz and exposes the portion of the MHz dial which is calibrated in MHz. To determine the frequency to which the receiver is tuned, merely read the MHz dial and add to it the indication presented by the appropiately calibrated portion of the kHz dial; thus providing the tens and hundreds kHz of the whole frequency number. When the 18.5-30 MHz converter is in use, the number 10 or 20 is added to the kHz and MHz dial indications.

Since the rf, mixer, PTO and PTO multiplier are all ganged together, only the single tuing control is required in the 1.5-18.5 MHz range. When the converter is in use, the converter rf tuning control (preselector) must be peaked to the selected frequency.



Front View

Conclusion

Although the construction of a receiver such as described herein, does require some cash, a large junk box and a considerable amount of time, it is most rewarding. And too, if you would like a receiver with all of the characteristics and features in the receiver described—where would you obtain it? If you could find one, you would most likely have to re-mortgage the homestead and car and leave two of the kids as security to finance the purchase. . . . K5WYG

Project Facsimile Antarctic

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BULLETIN . . . Successful transmission of the first facsimile picture by the Project Facsimile Group was made to KC4USV, Mc Murdo Station in the Antarctic on June 18th. The operations, a morale booster for the Navy personnel, have completed transmission of sixty more pictures since then. Project Facsimile Antarctic will continue to transmit more pictures each week through to October 15th, on 20 meters.

Project Facsimile Antarctic results may sound easy but there was lots of work, many hours and days in the preparation of the project before the first successful transmission of a picture was received at McMurdo Station.

It all began when your author was writing the article "Operations Deep Freeze . . . 1957-1967" (March issue of 73). With the successful facsimile operations that Paul Blum, W2KCR carried on with Little America in 1957, the idea came to repeat the operations in 1968. Contact was made with KC4USV, and inquiry was made, "would the personnel like facsimile pictures of their loved ones transmitted to them. The answer was "Yes."

This all started in November 1967 and from then on there was a lot of planning to do. Project Facsimile Antarctic was organized with WB6EGH, Ellis Wampler, Sr., WA6URW, Earl Darnell and your author forming the group to work on the project. The next order of business was to locate the facsimile equipment and get the permission of the Federal Communications Commission to transmit facsimile on the 20 meter band.

With new facsimile equipment not available, the word was put out on the ham bands that certain Times Corp. facsimile equipment was needed. The result was a surprise, to see the cooperation from amateurs and non-amateurs who loaned the necessary equipment for our project. In a short time the equipment was installed and local tests were made on the UHF band (420 MHz) to be sure of fault free operation. The results were good pictures at short distances but the big test was to come later when the pictures were to travel many thousands of miles to the Antarctic.

While waiting for special permit from the Federal Communications Commission, checks were made by WA6URW with KC4USV to get information as to signal quality needed to transmit the pictures. Under favorable band conditions WA6URW had no problems reaching KC4USV with sufficient signal strength for facsimile operations. The equipment at WA6URW is a Drake T4X Transmitter, Drake R4B Receiver, Drake L4 Linear and a Drake MN-2000 Matching Network. The antenna is a Mosley TA-36 erected on a tower 54 feet above ground.

It was now April 1968 and more work had to be done. Pictures of the families of the men at McMurdo had to be received before facsimile operations started. At this point, the Navy Relief Society at the Long Beach Naval Station offered aid in writing letters to the Navymen's families to sent pictures to their office for later transmission by the Project Facsimile Antarctic group. Pictures arrived from all parts of the United States and one from Rota, Cadiz, Spain. Some were pictures of new born babies and others of complete families. The new born

baby pictures were some the Navy fathers at McMurdo had not seen before. In the early part of May, Project Facsimile Antarctic received special authorization from the Federal Communications Commission for WA6URW to transmit facsimile pictures for morale purposes on 20 Meters. Everything was ready to go on the operations but we found magnetic storms in the Antarctic. With these conditions we had to delay our first facsimile transmission for a later date. These magnetic storms last from three days to two weeks and some frequently last a month. When band conditions did improve, tests were made with KC4USV on facsimile but the first picture transmitted was not perfect, due to fading. However, this first test proved we could get pictures to McMurdo when conditions were favorable.

Band conditions again in the early part of June were still plagued with magnetic storms but on the evening of June 19th, the first successful picture was transmitted and received at Mc Murdo Station. With the first taste of success, six more pictures were transmitted during the week June 22nd to 26th. Fortunately all of these were received satisfactory, and all of the Project Facsimile Antarctic group were thrilled about the results of the operation thus far.

Further plans are being made for a weekly newspaper (one page) giving sports news, sports pictures or anything which would be interesting to the men at Mc Murdo. A local paper is working on the details and the Antarctic edition should be ready shortly. The newspaper is to be called "The Mc Murdo News."

For those who are not acquainted with amateur radio operations at McMurdo Station, KC4USV it might be well to explain that the greater part of the operations is phone patching. As phone patch calls are a priority for the personnel, each evening, there is a limited amount of time for both facsimile and phone patch operations. Schedules are arranged with McMurdo Station for transmissions of facsimile each week to fit their routine. Although the phone patching is done on the Navy MARS frequency, facsimile operations can be going on at the same time on the 20 meter band. The facsimile signals are received at the communication center at McMurdo Station and the amateur radio activities are all from KC4USV.

Project Facsimile Antarctic has accomplished part of what it set out to do, and through the next few months the project will have completed many happy hours of boosting the morale of the Navy personnel stationed at Mc Murdo Station. . . . K6GKX

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A High Performance Receiver for Two Meters

Transistor circuitry has much to offer in the construction of VHF equipment, especially when trying to cram the highest possible performance level into the smallest possible space. The receiver described on the following pages was built as an attempt to make a compact package to be used on vacations and portable outings such as Field Day. As the construction and testing proceeded, it became apparent that the level of performance of the receiver was going to be at least on a par with regular station equipment, and perhaps above it. The finished unit shows a noise figure of 3.5 db measured on a Kay noise meter, selectivity sufficient to separate a strong local station from a weak one only 6 kHz apart, and absolute freedom from drift and instability.

The circuit uses Motorola MPF-102 field effect transistors in the *rf*, mixer and oscillator stages for low noise figure and excellent overload characteristics. The oscillator was first designed using conventional VHF transistors such as 2N706A and ZN3663, but was found hard to stabilize, especially with respect to warm-up drift. Using the field effect transistor completely eliminated these problems, and proved so stable that stand-by could have been accomplished by cutting the supply voltage to the local oscillator, a technique that would make old die-hard tube addicts shudder!

One problem encountered with an otherwise exceptionally stable oscillator was an extreme sensitivity to voltage changes. Many attempts were made to regulate the supply voltage, but the class B audio amplifier still caused enough change to affect the received signal. The final solution may not appeal to the purist, but it does work with a minimum of trouble. A pair of D flashlight batteries were mounted inside the case and turned

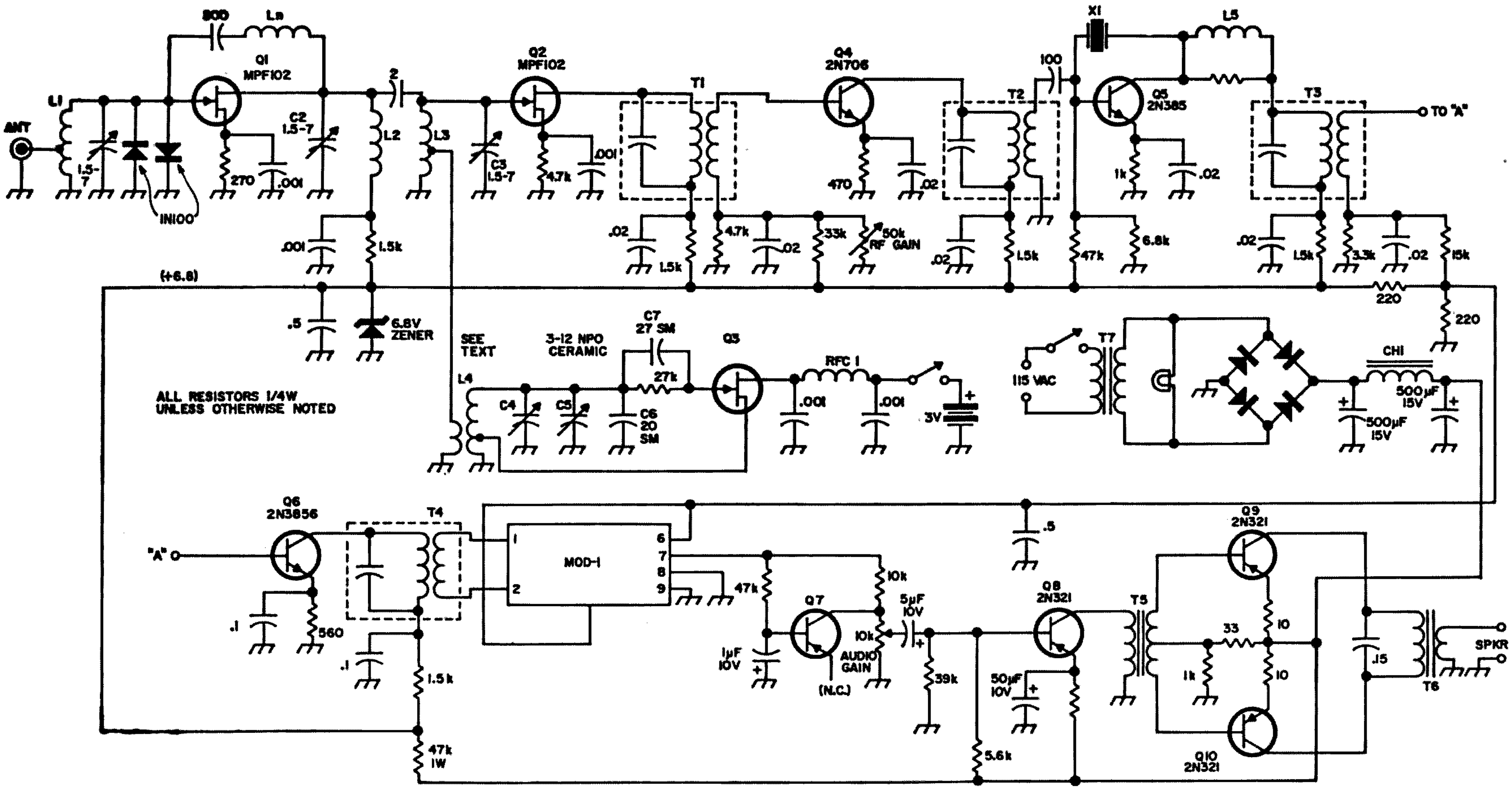


Fig. 1. Schematic Diagram

- T1 — 10.7 mc. FM input IF transformer, J. W. Miller 2070
- T2 — 10.7 mc. FM interstage transformer, J. W. Miller 2071
- T3 — 455khz input transformer, J. W. Miller 2031
- T4 — 455khz transformer, supplied with IF module
- T5 — driver transformer, 10K to 2K c.t. Midland 250633, Calrad CR75
- T6 — output transformer, 500 ohms c.t. to 3.2 ohms, Midland 25-631
- T7 — 6.3V, .6 amp or smaller filament transformer, Triad F-13X
- CH1 — 2 hy, 15 ma. low resistance choke, Stancor C2707
- L1 — 4t. #20 bare copper 5/16" ID 1/2" long
- L2 — 5t. #20 bare copper 5/16" ID 7/8" long
- L3 — 3t #BJ bare copper 5/16" ID 1/2" long tap 1t. from ground end
- L4 — 13/4t. #14 bare copper 5/16" ID tap 3/4 turn from ground end link 1t. #20 bare copper 1/4" away from ground end
- L5 — 200 microhenry RF choke, J. W. Miller 9210-90
- Ln — 8t. #26 enamel closewound at one end of 1/4" dia slug form
- RFC-1 — Ohmite Z-144 or 18 turns #24 wound on 1 meg 1 watt resistor
- X1 — crystal, 11.155 mc.

on and off with the power switch. Absolute stability now exists, and at 2.5 mA battery current I expect it will be a long time before replacement is needed.

The oscillator tuning capacitor, CI, is made from a Hammarlund HF-15 with all but 1 fixed and 1 movable plate removed. This is easily accomplished by holding the plates with long-nose pliers and bending back and forth. Doubtless many other similar capacitors could be used with minor changes in coil dimensions.

The oscillator tuning capacitor is mounted on a piece of copper-coated phenolic board, 2" by 1½" soldered along its entire length to the chassis board. A similar copper-phenolic board is mounted in front of the capacitor to support the dial assembly, leaving enough room for the front panel to clear the dial, and a flexible, insulated coupling to drive the oscillator capacitor. An insulated coupling is needed to eliminate a variable-length ground path for the oscillator capacitor rotor. The remaining oscillator parts are mounted as solidly as possible with the transistor socket resting on short, solid leads. Leaving the socket out would provide even better mechanical stability at the expense of easy transistor substitution. Not knowing much about field effect transistor stability at the beginning of this project, the socket was used.

The dial assembly is a Jackson model 4511/DRF, giving two speeds for accurate tuning: 36 to 1, 6 to 1. The dial drive mechanism is mounted on a piece of phenolic board soldered to the main chassis, and coupled to the oscillator board with a piece of metal tubing. This coupling reduces the backlash in the unit to an unnoticeable level, and allows very smooth tuning over the band. The dial itself was made from a piece of cardboard cut to 4 inches in diameter and mounted on the Jackson assembly.

The *rf* amplifier stage has protection diodes connected across the input coil to provide a path to ground for excessive *rf* voltages, as might be encountered when operating a transmitter near the receiver. Following the mixer is a single stage of *if* amplification at 10.7 MHz to help control the undesired images which might otherwise occur if the only *if* was 455 kHz. The completed unit shows 42 db supression of the primary image, which occurs 21.4 MHz below the desired 2 meter signal. A secondary

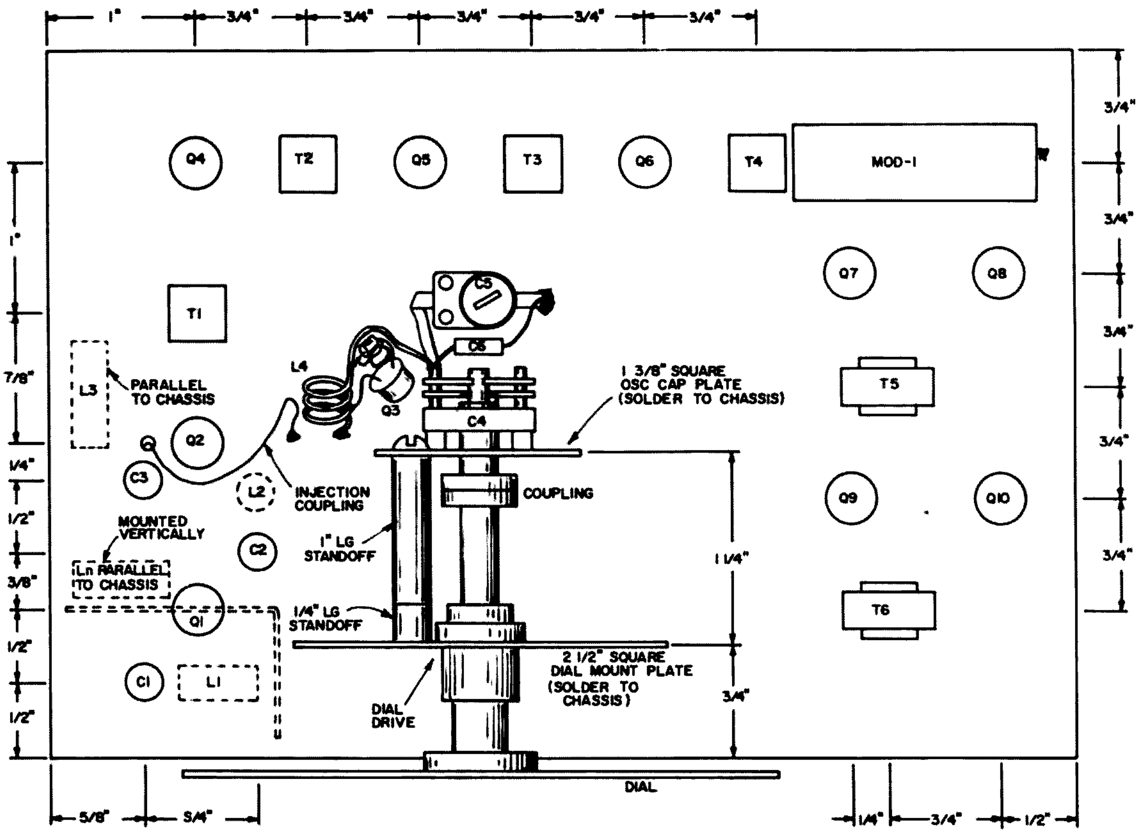


Fig. 2. Chassis Layout with dial drive assembly.
MOD-1 IF amplifier and detector module, J. W. Miller 8903B or Lafayette 99H6254

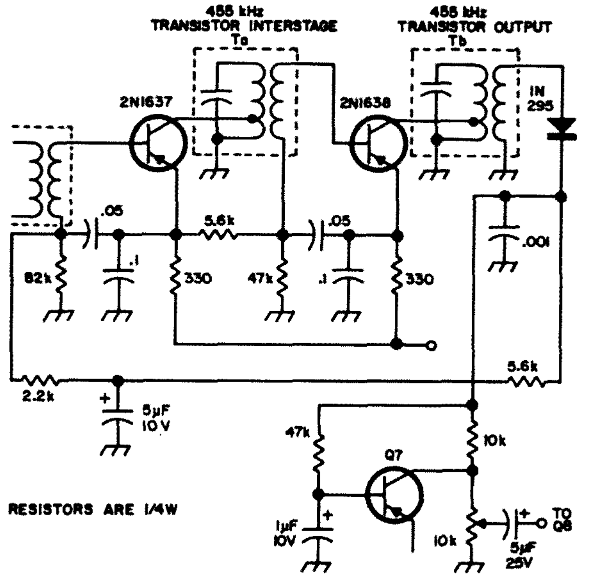


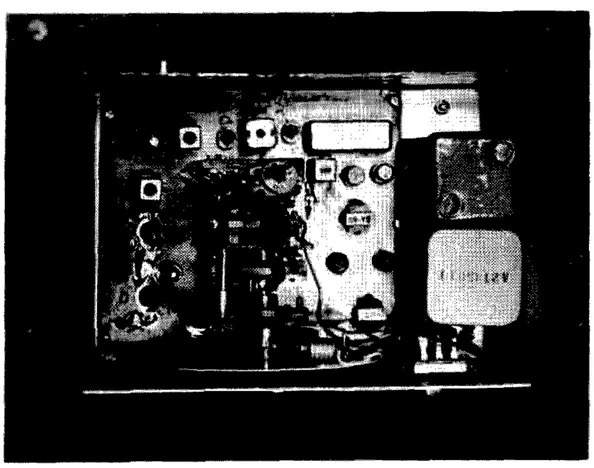
Fig. 3. *Optional* 455 *kHz If Strip to replace module.*

image is also noted, however, due to the low selectivity of the 10.7 MHz *if* transformers used, occurring at 910 kHz above the desired signal. This image response is down 36 db, and usually causes no trouble except when a strong local station is operating near the bottom edge of the band, the image then falling in the beginning of the technician band. An additional stage of *if* amplification at 10.7 MHz, or use of an additional *if* transformer loosely coupled to the 10.7 MHz output transformer would reduce the image to a negligible level. In actual use no images have been heard from outside the amateur band, and the in-band image only served to provide an additional spot to listen to strong locals. *if* gain control is accomplished by varying the base voltage on the 10.7 MHz *if* stage.

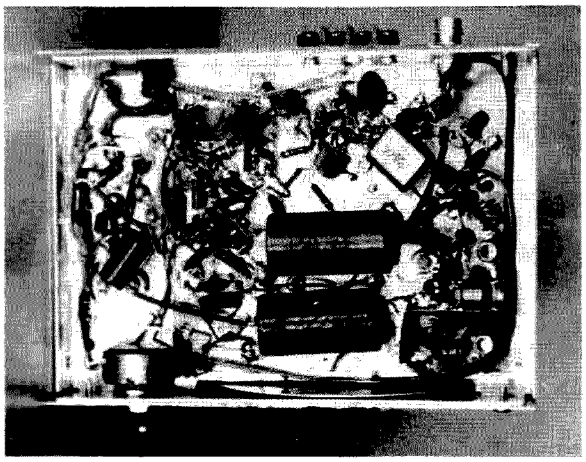
Following the 10.7 MHz *if* stage is a combined mixer-oscillator stage, using a crystal to beat the frequency. This circuit is an adaptation of one used in many pieces of commercial equipment, and provides excellent conversion characteristics without any tuning adjustment other than the input and output transformers. In the original model of this receiver, the 455 kHz *if* amplifiers were built on the circuit board. However, in the final version, a J. W. Miller pre-packaged *if* module was used as part of the circuit. Both schematics are provided so the builder can incorporate whichever design he prefers. The difference in operation of the two *if* amplifier designs are small, but the pre-packaged *if* unit provides better avc action than was obtainable with the separate design. The choice of transistors in the *if* amplifiers and converters is not critical. Both 2N706 and 2N3856 can be used interchangeably.

A very low voltage diode is required in the noise limiter circuit, and the most satisfactory unit seems to be the collector-base junction of a 2N107 transistor. Perhaps there are some separate diodes which have the required characteristics, but in trying over twenty types, none worked as well as the transistor specified. The audio stages need no special comment other than to note the power output is sufficient for any normal use. If higher audio output is needed, the supply voltage may be raised to 15 volts with a corresponding increase in output. The voltages on the remainder of the set should be held to the specified ones to avoid upsetting the conditions needed for maximum gain. This will automatically be accomplished by the 6.8 volt zener diode, but the supply resistor of 47 ohms may have to be increased to keep the zener dissipation within operating limits.

Power for the receiver is supplied by a 6 volt filament transformer and bridge rectifier assembly feeding a capacitive input filter to yield an output voltage of 7.5 volts under load. The transformer and choke shown are not those specified in the parts list, but some "junk box" specials. Those recommended have the same ratings. Receiver muting is accomplished by breaking the supply voltage to the entire receiver with the exception of the local oscillator. As mentioned earlier, stand-by can be accomplished by breaking power to the oscillator. This leaves the *rf* amplifier and mixer operating, and even with the protection diodes,



Top View of The Receiver.



Bottom View

the mixer gets a pretty good shot of *rf* when a transmitter is operating, if the *rf* amplifier is left running. Since breaking both the *rf* circuits and the oscillator would require two contacts on the mute switch, it was decided to let the oscillator run. The power transformer and choke used were surplus items picked up at a local "junk store," and somewhat smaller than those specified in the parts list. If the specified ones are used, the next size larger cabinet may be needed. One possible solution might be to use the smaller cabinet with the power transformer mounted on the back; another to mount all power components in a small mini-box and connect with a short cable.

In constructing the unit, it is strongly recommended that some two-sided copper-phenolic board be purchased and used instead of conventional chassis techniques. The necessity for soldering to ground many times, along with the high frequency and low impedences of the transister circuitry precludes the usual ground lugs and resulting long leads. The actutal copper board size is 4⅝ by 7⅛". A cut-out, 4 by 6½" was made in the aluminum chassis to receive the copper sub-chassis.

All transistors were mounted in sockets for initial testing, and probably could be lead mounted in the final model, but care should be taken to prevent excessive heat from damaging the plastic encased units. Assembly and testing of the unit can be done in stages beginning with the *rf* amp, mixer, oscillator and 10.7 MHz amplifier. Connection of the output of this combination to a communications receiver will enable the set-up to be accomplished without wondering about all stages at once. After the front end portion of the receiver is wired, a grid-dip meter is a big help in alignment. The *rf* gate and drain coils can be tuned, along with the mixer gate coil to 145 MHz. The oscillator coil should tune from 133.3 to 137.3 MHz with perhaps a small overlap for band-edge monitoring. Adjustment of the coil length and the trimmer capacitor on the oscillator should enable this range to be covered. Injection from the oscillator to the mixer is adjusted by bending the coupling link near the oscillator coil, although the amount of injection seems to make little difference in performance. The best procedure seems to be to tune in a signal and adjust the link away from the coil until the signal drops off, then increase the coupling somewhat beyond that required for maximum signal. Too much coupling will cause no problems, other than excessive interaction between the mixer gate coil and oscillator frequency.

Neutralization of the *rf* amplifier is mos easily accomplished by disconnecting the drain voltage and tuning in a rather strong local signal. The coil should be adjusted for minimum feed–through. It should be possible to drop all but the very strongest signals into the noise level by careful adjustment. If no strong local stations are on the air, neutralization may be done by leaving the drain voltage connected, and adjusting the coil through its range until oscillation is noted by strange whistles and ploops on the receiver. There should be two settings where oscillation will occur: the correct setting and midway between. While building various models of the front end, it was noticed that the neutralizing coil dimensions had to be varied somewhat for each model. Do not be afraid to add (or subtract) turn to Ln if it seems necessary. The 10.7 MHz *rf* amplifier stage can be peaked for maximum output with the communications receiver connected to the secondary to T_2. The second converter stage, Q5, needs no adjustment other than repeaking of T2 and peaking of T3; the crystal oscillator portion has no tuning adjustments.

After the front end is set up and working, the 455 kHz amplifiers can be connected and checked out. A separate audio amplifier connected to pin 7 on the *if* module will assure that if the signal sounds fishy, at least it isn't the receiver amplifier doing it! Peaking the *if* transformers is a simple job, but be sure to use the

fibre tools recommended for the purpose. The use of a metal screwdriver results in very short transformer life—usually about one turn of the slug is all you get. The writer originally tried inexpensive 455 kHz *if* transformers, the imported types sold as replacements for use in transistor radios, but settled on the slightly larger J. W. Miller ones. The selectivity is definitely better on the larger units, and the space saved by the ultraminiature units is not really that valuable in this receiver. Once the complete *rf* system of the receiver is working, the audio amplifier can be connected and checked out. The only comment about it is that the use of voltages higher than 9 volts for supply may require the changing of the bias resistors in the audio driver and out put stages. At 15 volts the 39 k driver resistor should be raised to 56 k ohms.

Calibration of the dial is done by using several known frequencies from a nearby transmitter and interpolating to find the points at 144. 145 MHz etc. Dial markings and panel labels were done using a fine-line felt-tipped pen, after which a couple of coats of clear lacquer spray were added for protection. The completed receiver was housed in a cabinet made by the LMB Company-Type W-1A, measuring 7" long by 5" deep by 4½" high. A Bud cowl-type minibox, 10" long, 7" deep by 6" high would easily enclose the receiver and poyer components sepcified. The entire unit was completed and checked out on the copper board first, then a hole to receive it was cut in the chassis and small sheet metal screws used to hold it down. The power supply was built on the metal chassis itself for better mechanical stability. One problem encountered in the final checking-out of the finished unit was in the mounting of the loudspeaker in the top of the cabinet. It seems that the FET oscillators are very stable unless shaken at an audio frequency! The resulting feedback sounds nothing like the microphonics found in most 2 meter tube oscillators—it makes everyone appear to have audio feedback in their transmitter! The frequency of oscillation is high due to the mechanical stability of the oscillator, with the end result of accusing stations being received of having problems. The solution can be reached by two approaches: One, place the speaker outside the cabinet. This works every time, but takes up extra space. Two, anchor the FET and socket extra epoxy glue to the edge of the tuning capacitors, and make the remaining parts so mechanically stable that they are totally unaffected by vibration. This method of attack removes 99% of the problem, but there is still a bit on very strong stations at very high audio levels. If desired, the receiver may be run from batteries, either a 9 volt source or higher with appropriate dropping resistors. If resistors are used to lower the voltage, it is recommended that the input power be fed through the filter system to act as a decoupling network in the absence of a low impedence normally furnished by the battery.

The completed receiver should truly be a testimonial to the statement, "a good things come in small packages."

. . . W2HUX

The Ham Workshop

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The ham workshop can be almost anything from a VOM and screwdriver to one with a complete set of test instruments and complete metal working equipment.

Oh! You say you don't have a workshop, well fellow hams you maybe missing out on a lot of fun in ham radio.

You hams who don't have even a VOM, what happens when your ham gear quits working properly? Pack it up and send it back to the factory. Well, I guess this is ok if you have lots of money, anyway it makes a lot of jobs for technicians at the factories.

Maybe you are the kind of ham who likes to fix his own gear or build something new. But, you say test gear cost lots of money? True the better test instruments cost more, but a Cadillac cost more than a Ford too. Good test instruments don't have to cost a lot, look around at some of the kits on the market today. Such as the new Heathkit IM-17 solid state VOM, with 4½" meter, one FET, four other transistors, test leads, carrying case all for $19.95, this would be a nice VOM for you if you are just starting out.

If you have a lot of test gear around the workshop, do you know how to use them? Using test gear is a subject in itself and I wouldn't go into it.

A workshop is also tools to help repair the trouble after your test instruments told you what was wrong. Every ham should have screwdrivers of different sizes, pliers (both long nose and side cutters). a soldering iron or gun, and rosin core solder.

A good place to start, for hams who don't have a workshop would be the above tools, plus a VOM or VTVM. As you work on more of your own equipment, you find you need more items, such as a signal generator, oscilloscope, VTVM (if you don't already have one), grid dip meter, *rf* probe, dummy load (you should have this already), an assortment of test leads, wire strippers, and a nut driver set. These are but a few of the items you can add on, not necessary in the order listed above.

If you go in for building your own ham equipment, you might need in addition to the above, such items as an electric drill (a must), drill bits, reamer, chassis punches (for tube sockets if you use them anymore), a set of files, a variable voltage power supply, BC-221 frequency meter, and a big box for miscellaneous parts carried home from a bargain sale for that future project.

Where do you put your workshop? Anywhere that you might have room. An extra room (if you are lucky), a corner of the basement, or in a corner somewhere else in the house.

When you build, where do you get your ideas? You need to take as many of the ham magazines and books as you can. Then, when you see a circuit, you can go to the workshop and build it up, add your own ideas to it, see what it will do and maybe even write an article about it. A bookshelf is then needed to hold all the books and magazines you have.

It doesn't matter which you have the big well equiped workshop or the one meter workshop, you should at least try to repair or build some of your ham equipment. Who knows, you might find out what's behind that panel and help yourself learn something at the same time. . . . WØPEM

The following Cryptogram was submitted by Fr. Robert O. Gardiner K1OXK

Defi-Gram

P SPOONLO UPQL UZNSZ NA YALE IM KMEYTPIL PXMIZLO SPOONLO MO PX NXILOKLENPIL AYDSPOONLO.–AYD-SPOONLO.

(Solution on pg. 57)

New Life for an Old Circuit

Darrell Thorpe
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Simple inxepensive VFO circuit can supply stable fundamental drive sources to 50 MHz and beyond.

The Clapp oscillator circuit has eclipsed all other circuit configurations when it comes to buildng a VFO with inherent stability. However, it is not generally known that the Clapp circuit (first described by J. K. Clapp in 1954) is based upon a design conceived by Jiri Vackar in 1949. Most naturally, it is called the Vacker circuit. The Vackar circuit for some unkown reason has not received much attention in ham radio publications, so it is hoped that this reintroduction of the Vackar configuration to the ham ranks will breath new life into an old circuit that has much to offer.

What it offers

The Vackar provides inherent stability that is superior even to the Clapp circuit or any of the other common circuit configurations that are often described in VFO articles. Moreover, the output of the Vackar oscillator can be made constant over a wide frequency range. For purpose of comparisons, the basic Vackar, Clapp and Colpitts circuits are shown in **Fig. 1**. Note the similarity of the Clapp and Vacker circuits which is as should be because the Clapp was derived from the Vackar. Also, note that Vackar is not a Colpitts.

The Vackar circuit is series tuned by CV and the tank is shunted by a large capacitor C2. In addition, the tuning capacitor, CV, can be large in respect to the other capacitors if a wide tuning range is desired, and a 2.5: 1 frequency range is practical. Or, the tuning capacitor can be small to cover a narrow band.

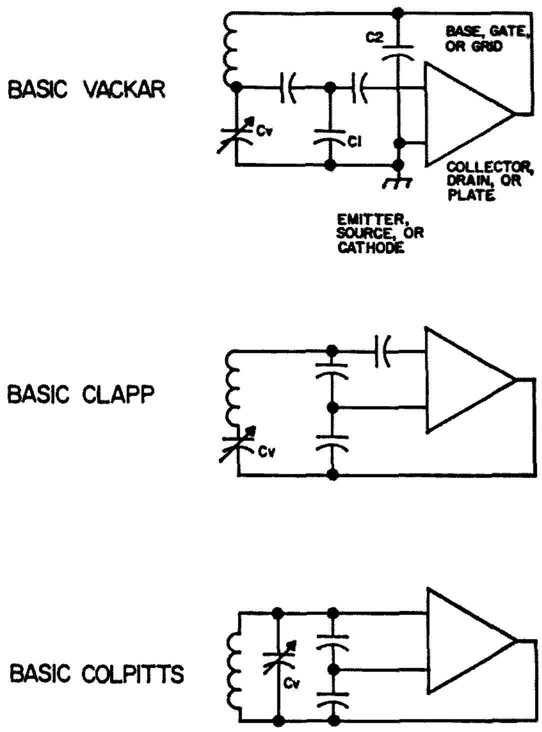


Fig. 1. Basic Colpitts and Clapp circuits are shown with The Vackar for comparison.

80-Meter VFO

A practical Vackar circuit suitable for operation in the 3.5 to 4 MHz range is shown in **Fig. 2**. However, as will be described, values can be changed to cover any other frequency range that is desired. The high Q toroid inductor together with CV, and C1 thru C5 form a resonant circuit at the VFO frequency. But, for all practical purposes, the value of CV, trimmer C3 and C4 together with L1 are the primary components that determine the frequency range. Note that C4 is not needed at higher frequencies. Capacitors C1 and C2 should be as large as practical, that is, the shunt reactance across L1 and the transistor should be small for best stability. To determine C1 and C2, which are the same value, at other frequencies use the following equation

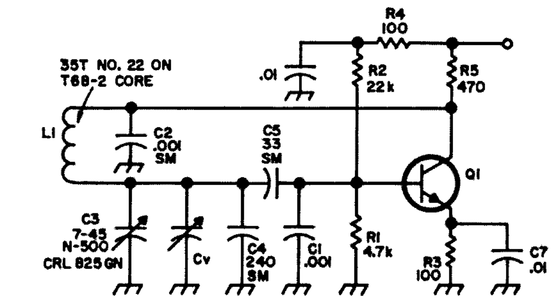


Fig. 2. Vackar oscillator circuit

$$C\ (pF) = \frac{3000}{f(MHz)}$$

Values determined from this equation will provide optimum stability and still remain consistent with other oscillator requirements. C5 should be small enough to prevent the transistor from being driven into saturation or into cutoff.

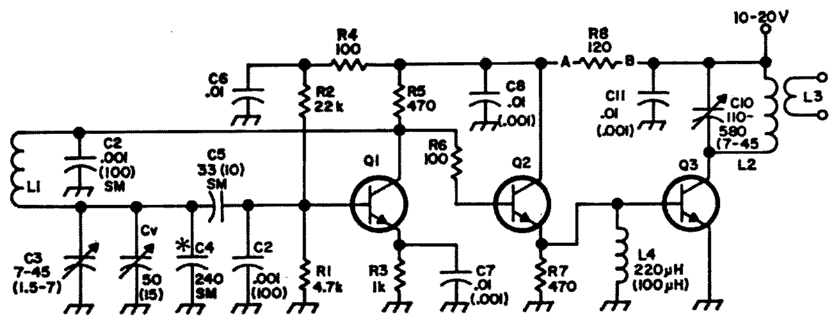
So, to get to another frequency, calculate C1 and C2, select suitable values for CV and C3 and padder C4 at lower frequencies, and then determine the inductance needed for LI to resonate with this amount of capacitance from charts in the radio handbooks. One other point of consideration is the decoupling provided by R4 and C6. This decoupling prevents spurious oscillations at audio frequencies and R4 must not be replaced by a choke because the choke which gives good rf decoupling would not give the necessary suppression of these potential audio oscillations.

VFO/Driver

Fig. 3 shows the basic Vackar VFO with an emitter follower isolation stage and low power driver stage. If the VFO is to be used in a stable temperature environment and not in conjunction with vacuum tube furnaces it will probably be stable enough without compensation. However, compensation can be provided by using an N500 trimmer capacitor for C-3.

For low drive power, the MPS 706 does a fine job in all three sockets, providing an output of about ¾ of a watt. But, if several watts of output are needed or if it is desired to use this unit as a QRP transmitter an RCA 2N2270 or 2N3053 (a real bargain at 75c) can be used in the final stage and the collector voltage upped to about 20 volts. If two of these devices are paralleled, you can put out a pretty healthy signal. Don't put more than 10 volts or so on the MPS 706 or you will lose it. The collector emitter breakdown voltage of the 706 is only 20 volts, and collector voltage should not exceed ½ of the collector-emitter breakdown voltage. The 2N2270 has a BV_{ceo} rating of 45 volts and the 2N3053 is rated at 60 volts.

The same printed circuit layout can be used to build this VFO/driver at any other frequency that may suit your fancy. The circuit board wiring is included for those who want to make their own board. However, if you don't want to fiddle with making your own circuit board, an etched and drilled board (type VFO-A) ready to mount the components to build a stable VFO at any frequency from 160 thru 6 meters is available from Circuit Specialists Co., P.O. Box 3047, Scottsdale, Arizona 85251. The price is $2.00 post paid. Also, toroid coil kits VFO-80 meter and VFO-6 meter including the two toroid cores and the specified wire are available at $1.00 per kit from the same source. Once you've gathered the few parts needed to go with your circuit board you can have a unit working in an hour or less. I've built several units at different frequencies and all worked immediately upon application of power.



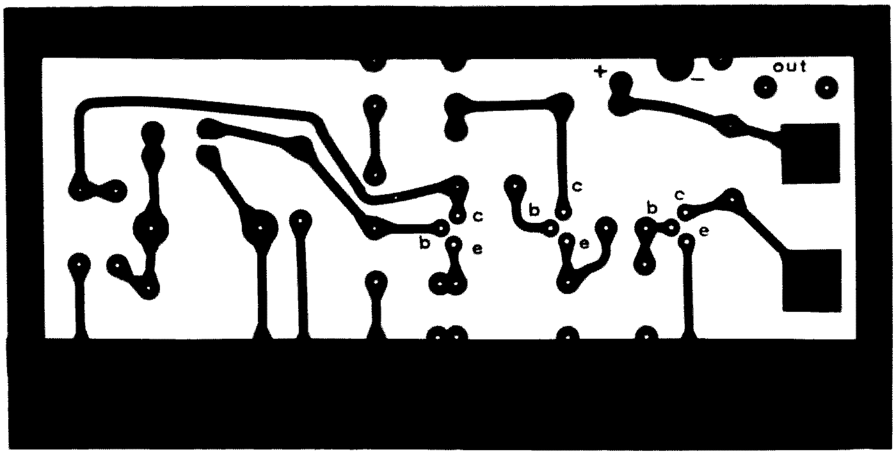
TO COLLECTOR-MODULATE FINAL:
OMIT R8
APPLY MODULATED VOLTAGE AT B
APPLY 9 TO 10V AT A

*C4 NOT USED IN 6M VERSION

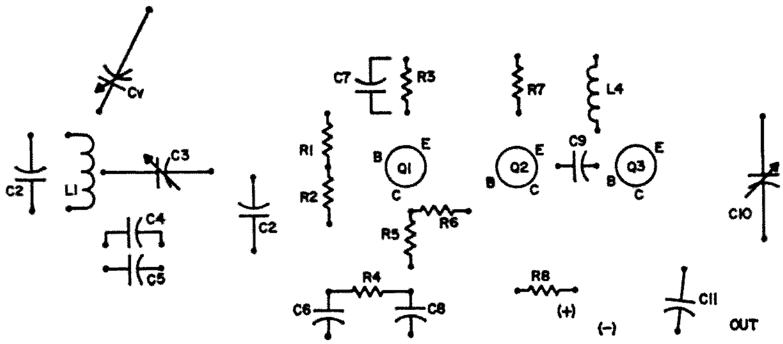
COIL DATA

COIL	80M	6M
L1	35T NO. 22 ON T68-2 CORE	9T NO. 22 ON T50-10 CORE
L2	SAME AS L1	SAME AS L1
L3	3 TO 4T NO.22 ON COLD END OF L2	SAME AS 80M

Fig. 3. Basic Vackar VFO



Printed Circuit Board foil side



Parts Layout for P.C. Board

6-Meter VFO/Transmitter

By simply changing a few of the values determining the resonant circuits the previously described circuit can be converted to a VFO controlled low-power 50 MHz transmitter or a driver for a higher powered final.

For stability over a wide temperature range, N-750 capacitors should be used for C1 and C2. Wth the toroid inductor and N-750 capacitors the drift due to temperature is negligible except at extreme temperatures. This unit was built as a test for several purposes, therefore an HF-50 variable capacitor was used and the tuning range is from about 40 MHz to 60 MHz. For 50 MHz only an HF15 would be more desirable. The turns on the toroid can be compressed or spread slightly and this together with the trimmer will set your bandspread. Note that C4 is not used in this version.

At 50 MHz, transistors became a little more of a problem. MPS-706's in all sockets seem to work, but the power output is low and VCC is restricted to about 10 volts. The 2N3053, which in the beginning I had high hopes for, proved to be a disappointment at 50 MHz. It worked pretty good at 40 MHz, and it probably would do a fine job on 10 meters. The RCA 2N5180 (available at 48c but not yet listed in the catalogs) does a fine job. Although it is a low power type, it is a VHF device (900 MHz) and therefore has good efficiency. Two or more 5180's can be paralleled for a pretty healthy signal. They are economical enough to be used in all sockets. The Motorola 2N2219 also does a fine job. In fact, almost any silicon NPN that has an f_t of 200 MHz or more would probably work. At higher voltage a small clip-on heat sink should be used.

. . . Thorpe

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VHF rf Noise Suppression

Probably one of the least understood problems with VHF mobile is *rf* noise suppression. After participating in, and listening to many conversations, it becomes apparent that a basic knowledge of the problem is lacking.

One of the most common complaints is that the converter or receiver is at fault because it picks up noise, or the antenna is at fault for the same reason. If the receiver and antenna are at all satisfactory, you *will* hear noise, for neither has intelligence to differentiate between the radio station to which you wish to listen and that being transmitted by the electrical system. True, most VHF receivers have some type of noise clipping which takes place either in the *if* section or second detector, or a blanker between the converter and receiver. It is also true that a narrow pass band in the *if* section will help; however, as most amateurs today are using commercial equipment, little can be done about this. Sometimes the location of the antenna will help, but these things in themselves will not cure all evils.

RF noise in mobile operation falls into two main categories. The first is conducted *rf* noise, and the second, radiated *rf* noise. Both types are quite broad banded. Conducted *rf* noise is that which is conducted along the electrical system of the car, and may originate from the alternator or generator, the voltage regulator, the points at the distributor, the windshield wiper motor, turn indicator flashers, etc.

The first step in conducted *rf* noise suppression is to remove the antenna from the receiver and short out the antenna jack. Turn the gain up and note the amount of inherent noise in the receiver (nothing can be done about this unless you want to rework the receiver). Start up the engine with the antenna jack still shorted. Rev the engine up and down. In most cases, you will hear alternator whine and distributor noise. Shut off the engine and start the windshield wiper. Increase and decrease speed. Shut off the wiper motor and start the turn indicator. Follow this through for any electrical device.

Now, for the conducted noise suppression: In some cars most of the electrical equipment conducted noise cannot be tolerated. In others, perhaps only two or three areas will require suppression. A great deal depends on the individual operator. In all conducted noise suppression, mount the suppressor as close to the offending equipment as possible. The reason for this is that as noise is being conducted along the electrical system, it can start radiating, and become an additional problem.

For alternator or generator suppression, there are two main types of suppressors. One is the tuned parallel trap, consisting of a coil and variable capacitor. This is connected in series with the lead from the alternator (as closely as possible). Of course this trap must be able to resonate at the desired listening frequency.

Now, with the antenna jack still shorted, and the audio gain well advanced, tune the trap for minimum noise. The second method, and my choice, is to install a feedthrough capacitor as close as possible to the alternator.

Perhaps a word at this time about feedthrough capacitors would not be amiss. A feedthrough, as its name implies, is one where the conductor, or lead, goes through the capacitor. The foil making up the capacitance is wound around this lead. The other lead of the capacitor is usually the metal case. From this it can be seen that inductive reactance is held at a minimum, and that any noise present on the line is forced to take this path. Be sure to scrape the metal clean in mounting capacitors. Do not use a wire ground lead, as the inductive reactance in the lead may defeat the purpose of the capacitor. As to the value of

the capacitor necessary, this will depend on the amount of suppression needed.

There are several companies who publish charts showing current capacity, frequency and suppression in db, and the necessary capacitance value together with the types of mechanical mounts. The current spoken about here refers to the amount of current the lead can pass. For example, if your alternator can produce 30 amperes, a 30-ampere type capacitor is needed. If the alternator can produce 60 amperes, a 60-ampere capacitor is needed. I was unable to acquire this information from the local wholesalers, but had to go directly to the manufacturer.

For those who do not have the time, inclination or ambition to follow this course, there are noise suppression kits available, consisting primarily of feedthrough capacitors. Instead of the capacitors being selected for any particular frequency, these kits are more of a brute force, general coverage type, and in most cases are satisfactory; however, for those electrical devices not covered by the kits, use feedthroughs.

Radiated *rf* noise. After the conducted noise is suppressed to your satisfaction, connect the antenna. Tune between stations, shut off the noise limiter and listen to the atmospheric and man-made noise. No type of suppression will affect this noise. The only thing affective here is previously mentioned blanker, clipper, etc. Start the engine and see how the noise increases. This radiated *rf* noise is that emanating from your autoelectrical system, and here is where radiated suppression counts. If your receiver and antenna are performing their functions well, the noise should increase considerably.

Now for the radiated noise suppression: First, be sure the receiver or transceiver is properly grounded. Do not rely on the Gimble mount for this purpose. Use broad straps. Two are better than one, and they should be as short as possible. Be sure the bolts used are large enough, and the surfaces clean. Now we look at the engine compartment. First, check the ground strap from the engine block to the frame. Clean and retighten. Install at least one more strap from the engine to the frame at some other point, and perhaps one from the block to the fire wall.

Remember, what is a satisfactory ground for your six or twelve volt system is not

good enough for VHF operation. In some difficult cases, it is also necessary to ground the muffler and tail pipe with broad straps, and sometimes it is even necessary to use wheel static suppressors. This wheel static can be detected best if you can find a road to yourself on a warm, dry day. At a speed of about sixty miles per hour, shut off the ignition switch and listen closely to the noise. As the car loses speed, the static noise will decrease and disappear as the car stops.

In some cases, you may have to ground the hood of the car. If so, use broad straps on each side, near the hinges. Make sure the ground connection at the base of the antenna is tight. Remember that a bumper or bumper mount is a very poor mount for VHF. If you must use the bumper, use broad metal straps from the base of the antenna to the body of the car, making them as short as possible.

As you have gathered by now, any part of the car that is radiating *rf* noise must be grounded. One simple way of detecting this is to use your receiver with a random length of coax connected to the antenna jack. At the opposite end of the coax, wind two or three turns of hookup wire, making a coil one inch in diameter. Tape the coax with the coil at the end to a yardstick. You now have an *rf* sniffer. By moving the coil around the car, you can detect areas of radiation.

The high voltage portion of the ignition system is something else again. The most common approach is to use resistor cable from the distributor to the spark plugs. This may be all right for the high frequency bands, but for VHF it leaves something to be desired. I prefer the resistive type of spark plug. The resistor is built right into the plug. Here we hear cries about poor gas mileage, etc., etc., etc. Remember, the purpose of the resistor is to minimize the jagged peaks found in the electrical wave form. If your high voltage is so marginal it must rely on these broad spikes, you have electrical problems. If you are going all out for suppression, there are kits available which will give maximum radiation suppression. Primarily, they consist of shields for the coil, distributor, high tension cables and spark plugs. (If you can stand the tariff).

In mobile noise suppression, how far to

go is entirely an individual matter. Also remember, two cars of the same model may require different measures. Antenna location plays some part in the amount of radiated noise pickup. For example, if there is radiated noise leaking around the hood, and the antenna is near this area, you will have noise. However, hiding the antenna behind the car is not the answer. Suppression at the hood is.

For those of us who must use city streets and freeways, how much suppression to strive for is a question, for nothing can be done about those cars in front, behind, to the right and left of us, except a very good noise clipper, blanker, etc. For those rare times when we get away from it all, and for those living in less crowded areas, use the greatest suppression possible.

. . . K6ZFV

Hallicrafters SR-400

The Hallicrafters SR-400 arrived the other day for an evaluation test. This is the first piece of gear that has turned up with my name on it, even temporarily, in about three years, so I got right at the rig to see what Hallicrafters had come up with and what improvements had come about since my last new transceiver.

Once you have become used to a one kHz per division dial I don't think you ever are comfortable until you get back to one. (I may write kHz, but until I pass into the great DX'pedition in the sky I shall think kilocycles.) The 400 has just such a dial and it is light as a feather. It also resets with absolutely no backlash. With a little practice I found I could set my dial to within 100 Hz (cycles) as easily as I can set some other transceivers to a kHz.

One knob on the front panel that I viewed with great relief was for the noise blanker. I don't know about you, but when I put my tower up I managed to find the worst possible place for it. My twenty meter beam virtually hangs over route 101, the major truck route east-west for this whole area. I'm right at the top of a medium sized hill so I get a good long shot over a quarter mile of road where the trucks are struggling to get up some speed after stopping at the one and only traffic light in Peterborough. The ignition noise often is staggering. So I just pulled the blanker knob and removed all those trucks from my speaker. Halleluja!

They have another little contraption built into this transceiver that is very handy. This is the RIT, the receiver incremental tuning control. On phone this means that you don't have to follow someone down the band if his transceiver doesn't really transceive. And you don't have to move your transmitting frequency every time someone calls you a little off the channel. You just move your receiver off a kHz or two and leave the rig where it was. This is great for nets on 80 meters where half of the fellows never seem to be able to hit the net frequency exactly.

The RIT can certainly be useful when you are working phone DX and you want to move off the channel just a little to work around a pileup. This is absolutely basic for CW DXing.

The 400 would seem to be ideally suited to the CW operator. Not only does it have the RIT arrangement for small QSY, but it has a 200 Hz filter position with an adjustable notch. That isn't enough for you? It has automatic break-in for CW and you can adjust the delay so you can have almost instantaneous break-in. What about monitoring your own signal? It has sidetone built in. Frankly, if Hallicrafters forgot anything in this package, I can't think what it is.

The 100 kHz calibration oscillator is built in and not, as on other transceivers, an accessory.

I found the rig simple to tune. It did take me a little time to get it on the air

because I wanted to test it through my Henry 2K linear and this required a couple of soldered connections to the power plug on the 400. I finally found a soldering gun out in the back of the barn storage area. Every last inch of solder had been lifted so I had to go downtown for that. And the mike used an Amphenol connector which I couldn't find around. Evans sent one down the next day and I was in voice.

My first contact was with Bert, ZL4IA, who said that not only was I by far the loudest signal on the band, but that the audio sounded excellent, every bit as good as AM. KR6JK was next, and Dave said that my signal was by far the loudest on the band and the audio teriffic. I worked about thirty other countries during the evening and in no case was I able to get anything but excellent reports. I tried turning up the mike gain to the top and giving the Amplified Automatic Level Control a workout. In the midwest, where my signals were booming in about 50 over nine, the reports were that my signal was about 3 kHz wide on the lower side and about 10 kHz on the higher side. That seemed to me to be remarkably good considering that I had everything wide open and the meters were going almost off scale.

In all, Hallicrafters has turned out a beauty of a transceiver. It is one which will do everything the hardened phone man could ask. It doesn't go all to pieces when a whalloping signal is just off frequency. It is nice and stable. When you calibrate it you know that you can depend on the dial telling you exactly where you really are in the band.

If you like your CW, as many of us do, you may have been frustrated at the short shrift that many of the present day transceivers give this half of amateur radio. The SR-400 obviously has been designed by a CW man for CW men. With all those frequencies opening up to the Extra Class licensees this coming fall I'll bet that a lot of you will be wishing your transceiver had some of the abilities of the 400.

Phone men will want the associated HA-20 remote VFO unit. This permits split frequency operation over a wider range than the RIT function, letting you work DX stations down around 14,100 while transmitting above 14,200. Most of the time I don't personally feel that this type of operation is in the best interests of the other fellows trying to use the band, but I recognize that it happens and when it does you don't want to have to swing your transceiver down to copy the DX station and then back up to the U.S. band to talk back to him. You'll do this about once before you call your distributor and get the HA-20.

. . . W2NSD/1

Technical Specifications

Tuning Ranges:
Full frequency coverage of the amateur bands in eight ranges from 3.5-30 MHz.

Types of Emission:
SSB—selectable USB/LSB with suppressed carrier either manual, or voice control.
CW—Keyed RF carrier either manual or break-in.

Dial Calibration:
One kHz increments, 500 kHz tuning range.

Frequency Stability:
Less than 250 Hz drift in first hour, after a fifteen minute warm-up, and less than 100 Hz per hour thereafter.

Power Supply Requirements:
Model PS-500-AC for 105-125V 50/60 cycle AC base station operation, or PS-500A-AC for 117-234V 50/60 cycle AC base station operation.
Model PS-500-DC for 12 VDC mobile operation.

Transmitter

Power Output:
SSB—200 watts PEP
CW—200 watts.

Distortion Products:
30 db signal to distortion ratio.

Unwanted Sideband Rejection:
50 db below desired output.

Carrier Suppression.
60 db below PEP output.

Receiver

Crystal Lattice Filter:
Six pole, symmetrical passband. Center frequency = 1651.4 kHz. B/W = 2.1 kHz (3db) B/W = 4.2 kHz (50 db).
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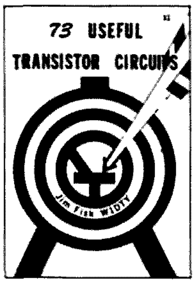

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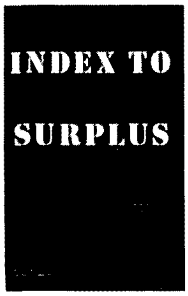

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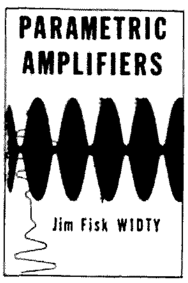

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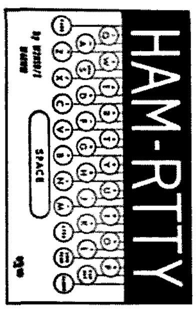

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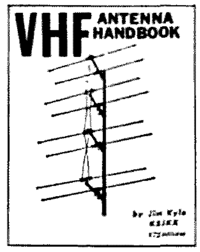

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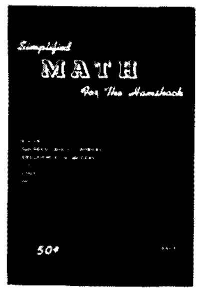
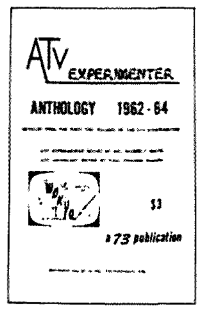


Does math scare you? It shouldn't in this easy-to-understand book K8LFI explains the simple exponential system of arithmetic, simple formulas, logarithms, and their application to the ham shack. **50c**

HAM TELEVISION



The Amateur Television Anthology is a collection of the technical and construction articles from the **ATV Experimenter**, edited by WØKYQ. If you're interested in ATV, this is the book for you. It covers the gamut from the simple to the complex in amateur television equipment. **$3**

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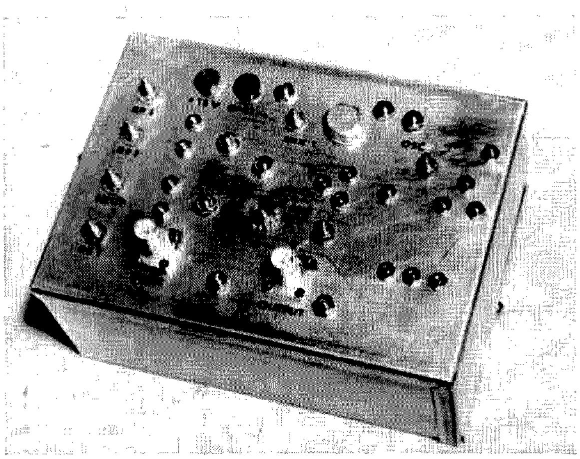
73 Magazine

Peterborough, N. H. 03458

A Low-Noise FET Converter for 50 MHz

by Robert D. Morrison WB6YVT
623 Sonoma Ave.
Livermore, Calif. 94550



Here is a FET converter which offers the extremely low noise figure of the new TIS 88 transistor, as well as good cross-modulation performance. This exceptionally low noise converter should be valuable to anyone interested in weak-signal 6-meter reception. The TIS 88 has a noise figure of 0.8 db at 50 MHZ and sells for $1.75 in single quantities. The ability to get below the atmospheric and man-made noise at 50 MHz to dig out the weak ones will be especially attractive for receiving skip signals during the approaching sunspot maximum. In this converter, the stability of a cascode *rf* stage, plus a TIS 34 mixer stage biased near cutoff insures high *rf* and mixer gains plus good overload control. The author also offers an optional bias circuit for the *rf* stage for those confronted with unusual antenna overload problems. The FET local oscillator should also be of interest to the ham builder, since there have been few FET receiver oscillators in the current ham literature. In summary, the clean, crisp reception qualities of this FET converter should be pleasing to everyone interested in 6-meter signals. The builder should be quite happy with the excellent performance of this unit.

Circuit description

The *rf* stage is a typical cascode circuit using a TIS 88 input and a TIS 34 output. The TIS 88 is a plastic version of the remarkable 2N4416, while the TIS 34 is a plastic version of the popular 2N3823. The cascode does not have a better noise figure than a single neutralized stage but was selected primarily for its better inherent stability.

The TIS 34 mixer stage is biased near cutoff for high local oscillator injection and conversion gain. This type of bias also provides good overload control and allows high *rf* stage gain. The cross-modulation distortion of the FET remains low even near cutoff. A TIS 34 is used in a series-mode local oscillator circuit. This type of circuit is recommended for overtone crystals. The oscillator tank output voltage at a 2K load is about 10 volts peak-to-peak. The crystal frequency of 43.000 MHz produces a converter *if* output of 7 to 11 MHz. This particular *if* frequency range was selected for the following two reasons. First, the converter should work well in this frequency range with low price receivers which usually have limited gain and frequency stability from 14 to 18 MHz. Secondly, the 58 MHz carrier of a local channel 2 TV station can produce an apparent 50.0 MHz image if a 14-18 MHz *if* frequency is used. In this case a 58 MHz antenna trap is required at the converter input. This reduces the sensitivity of the converter. However a 7-11 MHz *if* frequency eliminates the need for such a trap.

Construction

Two plain aluminum chassis boxes were used. A 4" x 2¼" x 2¼" (LMB No. 107) box was bolted to the bottom of a 7"x 5"x3" (LMB No. EL 753) box to form three partitioned compartments. The center mixer compartment physically separates the local oscillator and rf stages. This configuration reduces local oscillator pickup and

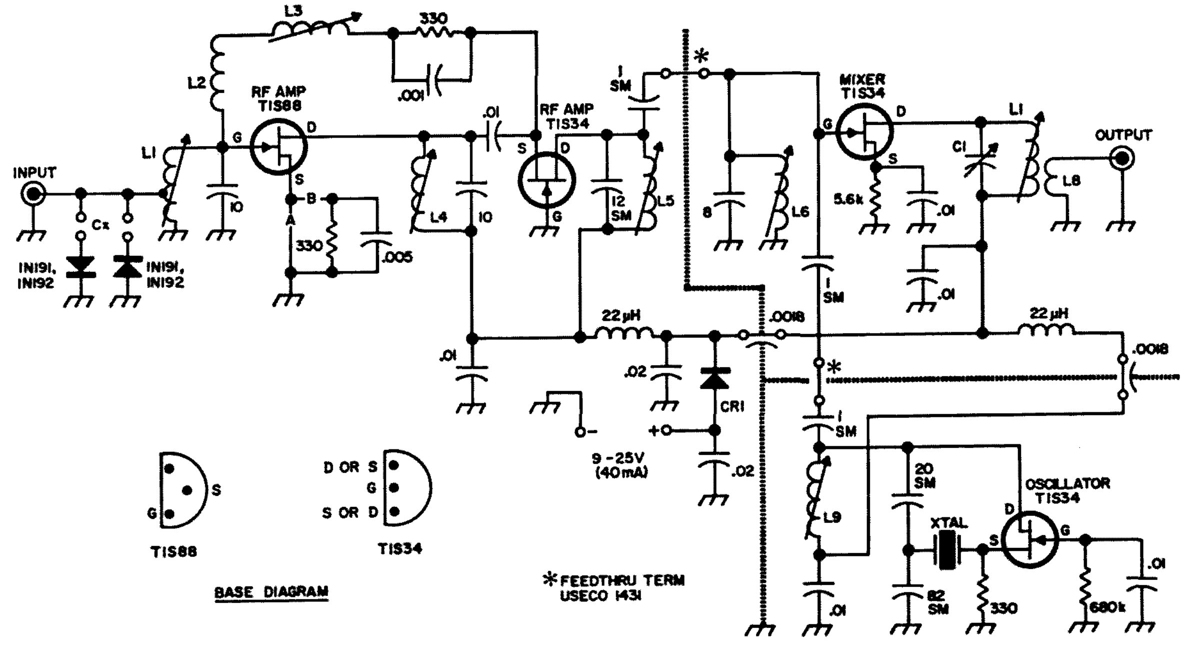


Fig. 1. Schematic diagram of the converter. All resistors are ½-watt carbon. All bypass capacitors are disk ceramic. Dipped silver mica capacitors are preferred for capacitance values below 100 pf., but disk ceramics are acceptable unless otherwise specified. The 1 pf. dipped silver mica capacitors are made by Cornell-Dubilier. For best sensitivity, connect the TIS88 source directly to a ground lug as at A. For better overload control, connect the 1N191 (or 1N192) diodes across J_1 as at CX, and then connect the TIS88 source to the 330 ohm (.005 mf.) bias network as at B.

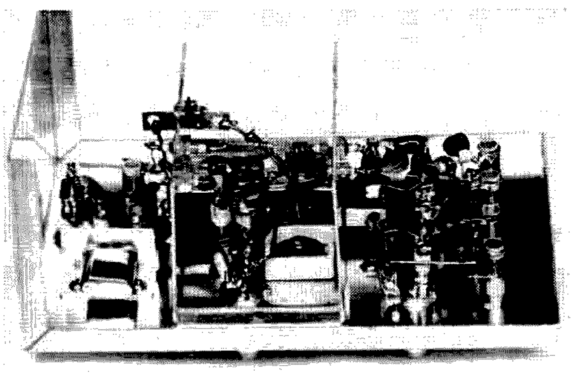
amplification through the *rf* stage.

An electrically continuous circuit ground from input BNC receptacle to output BNC receptacle has been provided by size 18 bus wire. All mechanical connections of wire, lugs, screws, and even BNC receptacle base are soldered over to provide this electrically continuous ground circuit. This technique may seem redundant but, in low noise circuitry, it is not particularly wise to depend upon mechanical connections for electrical continuity. Ground currents from one circuit, in general, should not enter the ground circuits of another circuit. This ground current isolation is most easily achieved by using only one grounding point for each circuit.

Transistor sockets are not used. The transistor leads are soldered directly to ceramic base standoff insulators (Useco 1460B). The transistors, barring electrical accidents, should never require replacing. Since the converter input is at dc ground, the TIS 88 should be well protected from dc overvoltages. The builder who is concerned with *rf* overvoltages or an unusually strong signal can protect the input with the optional diode and bias circuit described in the schematic diagram. These optional circuits will produce a very slight decrease in converter sensitivity.

Ceramic slug tuned coil forms are used throughout. Coil losses are most important in the input stage. A slight improvement in noise figure might be obtained by replacing the input coil and fixed capacitor with an air core coil and ceramic base air capacitor. The air core coil should be of large size wire and can be enameled, silver-coated, or bare. Tinned wire is not recommended. The coils should be at least one diameter distant from other objects. However, air core coils are not actually necessary since the converter already has a lower noise figure (2 db or less) than can ever be used at the fairly low frequency of 50 MHz with its high atmospheric noise level.

The ⅜" nut and bolt in the mixer selection is used only to fill a hole in the chassis. This hole has been used to hold an *rf* gain control. A 100 K or 1 Meg (audio) taper pot had been installed from mixer gate to ground and it provided several decades of good gain control. However, the mixer stage is now biased near cutoff, and this should provide enough overload control for all but the most unusual situations. No.



Inside the converter. rf stage on right; mixer in center; oscillator on left.

18 wire has been used in many places merely to obtain high mechanical rigidity. This rigidity adds frequency stability to critical regions such as the oscillator and neutralization circuits.

Finally, the outside of the aluminum chassis can be rubbed with sandpaper or steel wool to give it a pleasing white satin appearance.

Alignment

First of all, it is important that the power supply or battery have the right polarity when plugged into the converter. A medium current diode, with a P.I.V. of 50 volts or more has been set in series with the power input to prevent damaging the transistors. The converter will operate well for voltages in the range of 10-25 volts.

Connect the converter output to the receiver with a shielded cable. Without a shielded cable, 7-11 MHz atmospheric noise may mask the converter signals. Next connect a signal generator to the converter input. Set the generator at 52 MHz. Set all tuning slugs at mid-range. Adjust the oscillator coil slug until the signal generator signal "kicks" in. Then peak the mixer output, mixer input, *rf* output, and *rf* input, in that order. The oscillator coil may need additional peaking as the other coils are adjusted. Since the cascode rf stage is designed for high gain, it may be in oscillation at this point. Careful adjustment of the neutralization coil L_3 should stop the oscillation and bring the desired signal in loud and clear. Neutralization of triode type receiver circuits can be difficult especially for the inexperienced builder. However, once

Parts Data

SM—Dipped silver mica.
L_1—8¼ turns No. 24 enam. wire closewound on ¼ in. diam. slug tuned form. Tap 1⅝ turns from gnd. end. (Miller 4500-3).
L_2—10 uh. molded r.f. choke (Miller 9230-44).
L_3—Slug-tuned, 9.9 to 15.0 uh. (Miller 4506).
L_4, L_5, L_6, L_7, L_9—Slug-tuned, .44 to .76 uh. (Miller 4501).
L_8—2½ turns No. 22 insulated wire wound around L_9. Winding direction same as L_9.
RFC_1, RFC_2—22 uh. molded r.f. choke (Miller 9230-52).
CR_1—Silicon diode (optional), 50 P.I.V. minimum, 200 ma. min.
J_3, J_4—Banana jack.
C_7—15 to 130 pf. mica padder (Arco-Elmenco 302).
J_1, J_2—BNC receptacles.
XTAL—43.000 MHz, third-overtone, series resonant crystal.

the neutralization technique is learned and the circuit stabilized, the low noise performance of the triode stage more than compensates for the tedium of neutralization. Tapping of the bare finger on the *rf* stage output coil should produce a loud clunk in the receiver speaker and a jump in the S-meter. While so tapping the finger, the neutralization coil should be adjusted for smallest clunk in the speaker and smallest jump in the S-meter. This will be the approximate neutralization point, and the stage should be stable. Remove the signal generator and replace it with an antenna. The atmospheric noise can be used for the fine adjustments of all previously peaked circuits. A 50 ohm noise generator can be used to obtain the very lowest noise figure.

At VHF frequencies, tuned circuits are quite sensitive to component geometries. The geometry of the builder's circuit may differ somewhat from that of the author's so, to properly cover the 50 to 54 MHz range, it may be necessary to slightly change some of the values of the capacitors in the various tank circuits. It may also be necessary to change the value of the RFC L_2 used in the neutralization circuit.

If a TIS 34 with an extremely small gate-to-source cutoff voltage is used for the mixer, the local oscillator injection level may be too high. This will cause cross-modulation distortion and a profusion of clunks and bleeps across the band. This could be remedied by changing the values of the coupling capacitors C_{11} and C_{12}. However, for most cases, it should be enough to merely try other TIS 34's until the distortion ceases.

The converter is designed for 50 ohm and output impedances. If the receiver used

does not have a 50 ohm input, the number of turns of L_8 should be adjusted for maximum gain

The measured converter noise figure is about 2 db or less. The measured converter gain is about 30 db. Further reductions in noise figure could be obtained by the selection of an especially quiet TIS 88, and by the use of a very high Q coil-capacitor combination at the converter input. However, a 2 db noise figure is more than adequate for six-meter work.

Since the converter gain is high, an unusually strong signal may cause the converter to overload the communications receiver used as the *if amplifier*. This overload problem can be avoided by placing an attenuator between the converter output and receiver input.

I would like to thank Texas Instruments, Inc. for the sample TIS 88 transistors used in the development of this converter.

. . . WB6YVT

Hy-Gain Announces New 6-Element Tribander

Hy-Gain Electronics Corporation, Lincoln, Nebraska 68501 has announced a new 6-element tribander beam, The Super Thunderbird TH6DXX, for 10, 15, and 20 meters.

A new feature is a cast aluminum, universal tilt-head boom to mast bracket that accommodate masts from 1¼" to 2½" and allows easy tilting for installation, maintenance and tuning. It also provides mast feed-thru for beam stacking.

Another exclusive Hy-Gain feature is taper-swaged, slotted seamless aluminum tubing on all elements which allows easy adjustment and re-adjustment. Taper-swaging permits larger diameter tubing where strength is important and less wind loading at the tips. Full circumference compression clamps are mechanically and electrically superior to self-tapping sheet metal screws.

All Hy-Gain Thunderbird beams incorporate the Hy-Gain invented Beta Match system for balanced input, optimum matching on all 3 bands and dc ground to eliminate precipitation static. And, new, improved separate HY-Q Traps on each band.

The Super Thunderbird specs include up to 9.5db forward gain, 25db front-to-back ratio, SWR less than 1.5:1 on all bands, and a 24 foot boom (none longer in the industry).

Hams interested in further information should write to Hy-Gain.

Neutralization!

Roy A. McCarthy, K6EAW
737 W. Maxzim Ave.
Fullerton, Cal. 92632

"Neutralize: to make of no effect by some opposite force; counterbalance.[1]" Obviously, this is of concern in amateur radio transmitters, to prevent self-oscillation in amplifier stages. The receivers, using superheterodyne circuits and pentode or tetrode tubes, have not generally required neutralization on the individual stages. Well, not until the advent of the triode transistor. In fact, not since the early 30's.

To obtain oscillation, and substain it, requires a gain of at least one, and feedback in phase with the input. Let us consider then, a typical grounded cathode amplifier, as has been simplified in **Fig. 1.** Assuming the grid and plate tank circuits are tuned to resonance at the operating frequency, where is the feedback path? Since the tube reverses the phase by 180°, any feedback through the grid-to-plate capacitance would approach 180° if this capacity is large, or 90° if it is small. As it works out, tubes with the larger grid-to-plate capacity seem to be the greatest offenders. That is why tetrode and pentode tubes were developed-to cut down the interelectrode capacity. But, this fedback is 180° out, negative feedback, is it not? So, we go to the bottom of the tank circuit, either grid or plate, and send back a *positive* feedback signal to counterbalance it. Or, do we? *If* the circuits in grid and plate are tuned to resonance, they are resistive, hence no phase shift. The tube reverses the phase 180°, so the feedback through the grid-plate capacity can't possibly be zero. Take a grounded grid configuration, however, and with the same conditions, the feedback does approach zero phase shift. Although the grid acts as a shield between the two tuned circuits in this case, stray capacitance (or other un-

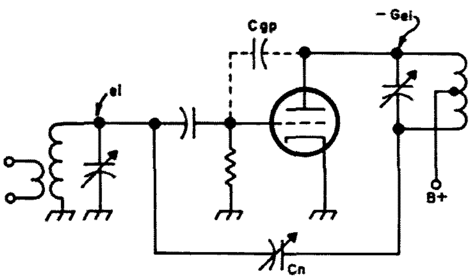


Fig. 1. Typical grounded cathode amplifier circuit.

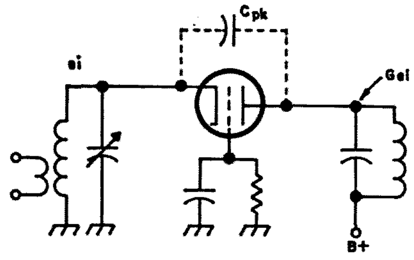


Fig. 2. Grounded grid circuit.

expected impedances) may create oscillations.

We certainly do tune the circuits to resonance, so there must be another explanation. There is! The circuits tend to oscillate at *another* frequency where the gain and phase shifts add up to the required specifications, 1 & 0, respectively. This is why, on the CW bands in particular, you may hear harsh broad key clicks, yet no carrier is present. Tune 50 or 100 kHz away and you may find the carrier that is being keyed, with only a trace of clicks. As the tube is keyed, its gain, and the effective grid-plate capacity (which are interrelated at *rf* frequencies) also vary. At some points they hit a happy medium and random oscillations occur. The effective C_{gp} is the product of the gain and the static C_{gp}. The effective gain is determined in part by the negative feedback through C_{gp}. Except for the unfortunate circumstance where the circuit is not so heavily loaded that it's reactance is negligible over a broad band. Then phase shift sets in and oscillations occur. And people promptly tell you to add a capacitor from the other end of the plate tank back to the grid. (C_n).

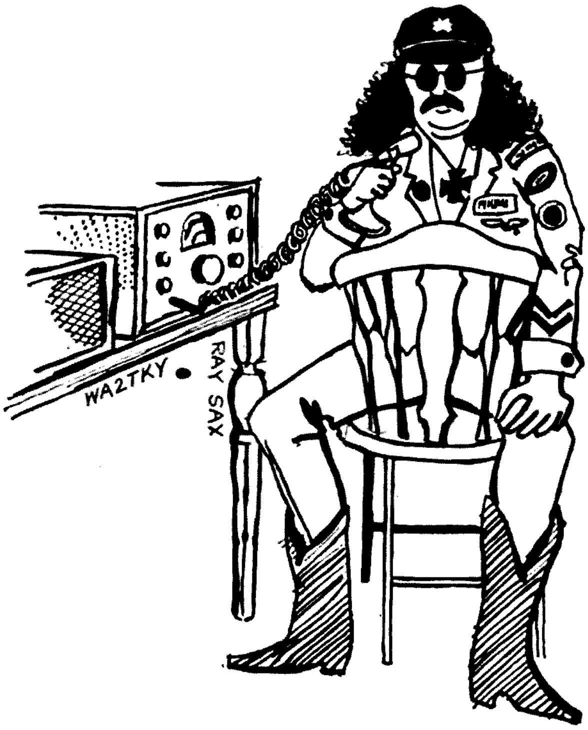
This *is* positive feedback, at the operating frequency, but it is compensated for by the negative feedback through the tubes interelectrode capacity. That is, at *your* operating frequency. At other frequencies, it is negative feedback (hopefully). Any filter has phase shift, and the grid and plate tank circuits are definitely no exception. The higher the Q, the greater the phase shift *near* the operating frequency. And naturally the gain is higher closer to the operating frequency, since the circuit is designed to match the amplifier, be it tube or transistor.

With all the possible stray impedances present in an amplifier using a high G_m tube at the higher frequencies, proper neutralization is extremely difficult, and may require a combination of two or more methods. But *few* of them use negative feedback at the intended operating frequency.

By referring to the grounded-grid schematic, it will be noted that this configuration does not reduce the problem of grid-to-plate capacity, it eliminates it. The remaining problem is cathode-to-plate capacity, and, of course, grid lead inductance. In one recent article[2] the author claimed "any plate-grid capacitance now feeds the signal back in wrong phase to regenerate." I couldn't agree more. It feeds it straight to ground.

. . . K6EAW

References: 1. World Book Dictionary.
2. ham radio, April '68, page 18.



"Yeah, man, like 73"

Defi-Gram Answer

A carrier wave which is used to modulate another carrier or an intermediate subcarrier.—subcarrier . . . K1OXK

Getting Your Higher Class License

Part VII — Measurements

In the preceding six installments of this study course for the Advanced Class license exams, we've leaned heavily on theory—because the point of the whole series is to provide the additional theory you'll need to pass the exam!

But all this theory must be tempered somewhat with its practical applications. Any practical application of any part of the theory is going to involve some type of measurement — even though we may not realize that we're making it.

For example, simply tuning a receiver is making a measurement of the receiver local oscillator's frequency; when a station is tuned in "on the nose," the receiver oscillator is operating at a "measured" frequency. Just what the measurement may mean is a different question.

Most measurements we make are more deliberate than that; we may measure time in order to make our log entries, frequency in order to stay within the band limits, current in order to tune our transmitters, and voltage (via the S-meter) to check received signal strength.

The Commission recognizes the importance of measurements in practical applications of theory, and several questions dealing directly with measurement are included on the FCC study guide. Among them are (numbers are from the FCC list):

10. How close to the edges of a certain amateur band can you safely operate a VFO-equipped CW transmitter if you are using a frequency meter which has a maximum possible error of 0.01 percent?
16. What do oscilloscope patterns showing 25% modulated signals (with no distortion) look like? 50% 75%?
22. What are Lissajous figures in oscilloscope operation? What patterns would be produced on the oscilloscope if the signal applied to the horizontal input has a frequency equal to 2 times the frequency of the signal applied to the vertical input? 3 times? 4 times?
37. Should a voltmeter have high, or low, internal circuit resistance? Explain.

These four questions, with their many parts, actually span almost the entire art of making electrical measurements. As usual, we'll re-phrase them to make the basic points a little more obvious, and move the emphasis from that of specific answers to specific problems over to that of the general reasoning behind typical problems.

The first question, in this phase, must be "What is 'measurement'?", for most of us probably think of it as something more than it actually is.

Directly following from the first is the second, "How are measurements made?". The third, "How accurate can measurements be?", naturally accompanies the second. One of the remaining key factors is the question, "Can a measurement affect itself?", and of vital practical point is the final question of our paraphrased group: "What are measurement 'standards'?"

Ready? Let's go.

What Is "Measurement"? The word "measurement" means many things to many persons, but most of us tend to think of it as a process including more than it actually does.

A measurement cannot be anything more than a *comparison* of two like quantities, to determine whether they are equal, and if not, which is greater. The mythical scales of Justice are a typical example of measurement at its most rudimentary level.

One of the two quantities—the one which we are "measuring"—is unknown. The other, hopefully, is known, and we call it "standard" against which we are measuring the unknown.

When our comparison device is able only

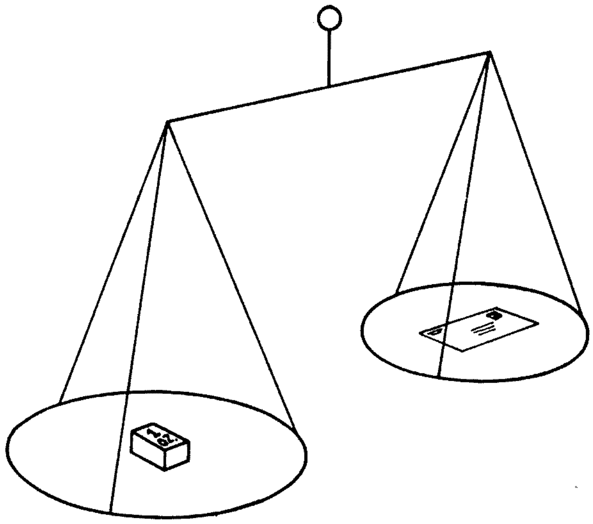


Fig. 1—Comparison of the unknown quantity (such as the weight of the letter) and a known standard (the 1-ounce weight) forms the basis of all measurements. Any measuring instrument which does not have the comparison standard within itself is merely acting as an indirect comparison device. In this case, the initial comparison to a standard is known as "calibration" of the instrument.

to indicate exact correspondence and relative unbalance, we must have not just one but many "standards", each of which bears some relation to the others. Staying with weight and scales for our example, we would need not only 1-pound standards but also 1-ounce, 2-ounce, 4-ounce, 8-ounce, 2-pound, 4-pound, and 8-pound standards in order to be able to "measure" unknown weights from 1 ounce to 16 pounds within 1-ounce accuracy.

Some comparison devices are able to indicate the amount of unbalance more precisely; we'll get to them a bit later. The point we're looking at now is the fact that *all* measurements are forms of comparison against standards. Sometimes the measurement includes a counting action (as in measurement of time by a clock) but the comparison to a defined standard is always involved.

In ancient history, the standards were considerably less precise than those we use today. The biblical standard of length, for instance, was the cubit—which was the length of a man's forearm. Just how many cubits long a wall happened to be depended upon whose arm was used to establish the standard. As recently as the middle ages, the english-standard "foot" (which today is defined as 12 inches) was defined as the length of the right pedal extremity of the reigning monarch —and varied all over the kingdom when a new King took the throne.

Our electrical standards are much more precise, even if they do happen to be phrased in the language of physics. A volt is defined as the potential produced by a specified type of primary-standard cell. An ohm is defined as the resistance of a particular and highly-specified conductor. An ampere is defined as the current required to electroplate a given quantity of silver out of a solution of specified strength. Additionally, each of these standard "units of measurement" is defined in terms of each of the others by means of Ohm's law, and the whole system of physical units is geared together so that all the equations of physics hold true.

When we measure a voltage in a circuit, though, we aren't performing any such direct comparison—and what we actually measure is *not* voltage, but length! How this can tell us the voltage in the circuit is what the next question is all about.

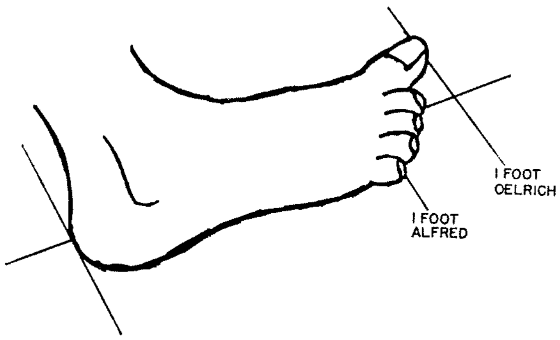


Fig. 2—In olden days, standards were a bit less precise than those we use today. The standard of length in England through the Middle Ages, for instance, was the King's right foot—whence comes the name of the unit. This was some slight hardship to surveyors when the reign changed, but most people could live with it and those who couldn't, didn't, courtesy of the royal executioner.

How Are Measurements Made? If measurement means only a comparison of an unknown quantity against a standard, how can it be possible for us to measure the voltage in a circuit by using a voltmeter which does not contain any standard voltage source against which the unknown can be compared?

The answer, surprising though it may be, is that it's not. We speak of measuring voltage, but we don't. What we actually measure is *length*—the distance across the meter face travelled by the needle—and the comparison standard is the printed scale under the needle.

How can length indicate voltage? Again, it doesn't; what it does indicate is power. In the

ordinary moving-coil meter movement, the electrical quantity which is measured is power. This power forces the meter needle against a spring in some cases, but in more sensitive meters the power is only capable of pushing the needle partway across its scale. The deflection of the needle is proportional to the applied power, and since the meter is of fixed construction, the distance travelled across the scale by the needle can be used to indicate the power.

We normally calibrate meters to indicate either voltage or current, rather than power; in a circuit of fixed resistance, though, either voltage or current may control the amount of power available. If the circuit resistance is low, then current is usually the controlling factor. If circuit resistance is high, voltage indications are obtained. One rather unusual result of this is the fact that a milliammeter, calibrated for current, can be used without any modifications for measurement of extremely low voltages. If the resistance of the meter movement itself is 100 ohms, for instance, and full-scale deflection is obtained with 1 mA of current, then the meter may also be used as a voltmeter in the range from 0 to 1/10 volt. When 1/10 volt is applied to a 100-ohm resistance, the resulting current flow is 1 mA—and that's full-scale deflection for the meter. At least one commercial VOM makes use of this capability to provide a very-low-voltage range.

Don't become confused by this approach—the power used by the meter is *not* related to the power consumed by the circuit being tested. To measure power consumption of the circuit, two meters are normally required; one measures the current flowing through the circuit and the other measures the voltage. Certain special meter movements have been built (mostly for ac uses) to combine both these measurements in a single meter, and indicate power directly on the scale, but you are not likely to run into any of these meters in practice.

The type of measurement we've been examining thus far in this section can be called "indirect", since we are not making a direct comparison and so are not, in the strictest sense of the word, measuring what we think we're measuring. Indirect measurement can be summarized in the idea that we actually measure something which is *related to* the quantity we want to know. The process of establishing that relation so that we can trust our instruments is known as "calibration",

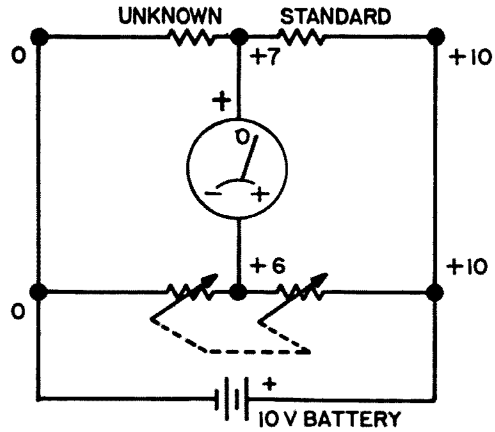


Fig. 3—Wheatstone bridge circuit shows direct comparison measurements. Figures in drawing are typical only. If adjustable ratio arms of bridge divide the 10-volt source into 6 and 4 volts respectively (3 to 2 resistance ratio) while unknown and standard together divide it into 7 and 3, the 1-volt difference appears across the meter and causes the needle to deflect. When the ratio arms are adjusted to also provide 7-3 voltage division, no voltage exists across meter and deflection is zero. At this time, unknown bears same relation to standard as left-hand ratio arm does to right-hand ratio arm. This performs direct comparison of unknown and standard.

and could be the subject of an article in itself. Most often, calibration is accomplished by making a "direct" measurement and an "indirect" measurement at the same time, and adjusting the "indirect" instrument as required to make its reading correspond with that obtained directly.

"Direct" measurements involve direct comparisons between the unknown and the standard. One of the most widely known examples of this type of measurement is the Wheatstone bridge, used to measure resistances. Other examples include the Kelvin-Varley potentiometer (not to be confused with the variable resistor of similar name) for measurement of voltages, capacitance bridges, impedance bridges, and some types of frequency-measuring devices.

The action of the typical bridge circuit is shown in **Fig. 3.** The bridge contains four "arms", one of which is the unknown resistance and one of which is the standard. The other two arms are also standards, but are variable so that their ratio to each other can be changed. A "null indicator" which may be a sensitive dc meter or some other current-indicating device is used to detect the "balance" condition. Current is provided to the bridge circuit, and the ratio of resistances in

the adjustable-standard arms is varied until the indicator shows an *absence* of current flow through the center leg of the circuit. When this condition occurs, the ratio of the unknown resistance to the fixed standard is the same as that of the corresponding adjustable standard to its mate; a simple calculation then produces the value of the unknown resistance.

This works because current will flow between any two points which are at different voltages, but cannot flow between two points at the same voltage. Current flowing through the two adjustable standards produces a voltage drop across each; similar voltage drops are produced across the unknown and the fixed standard.

The bridge leg, which contains the null indicator, connects these two path midpoints. If the voltage drop across the left-hand adjustable standard is not the same as that across the unknown resistance, the two ends of the null-indicator are at different voltages and current can flow. When both voltage drops have the same value, both ends of the indicator circuit are at the same voltage and current flow ceases.

The absence value of the unknown resistor need not be the same as that of the left-hand adjustable standard, though, because the total current flow in each of the series-resistance legs is also affected by the resistance of the fixed or the right-hand adjustable standard, as

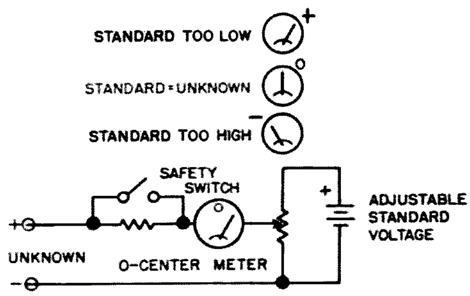


Fig. 4—This slide-back voltmeter circuit, while too simplified for practical use, illustrates another application of the direct comparison technique. The resistor to left of meter simply protects meter against overvoltage; switch is left open until reading approaches zero, then closed to make instrument more sensitive. When the standard is of lower voltage than the unknown, current flow through meter is from left to right and needle deflects to right. When standard is greater than unknown, current flow reverses and needle goes to left. When standard and unknown are exactly equal, no voltage exists across meter and deflection is zero. Accuracy depends upon precision with which standard can be adjusted.

applicable. The factor which establishes the voltage drops developed is the *ratio* of left-hand to right-hand resistance in each leg; an identical voltage drop means an identical ratio, and since three of the four resistances are known, the fourth can be easily found.

Voltage measurement can be done in a similar manner, and the "slide-back" voltmeter shown in **Fig. 4.** does just this. The voltage to be measured is applied to the circuit, and it deflects the null-indicating meter. An adjustable standard voltage is applied to the other side of the meter to cancel out the effect of the voltage being measured. When the two voltages are equal, the meter indicates no current flow. Such a meter takes no power from the circuit under test—the "no power" indication is used to signal that the adjustable standard is equal to the unknown voltage.

One of the most essential instruments for measurement of modulation quality and performance of linear amplifiers operates in a direct-measurement mode. This is the oscilloscope, which is essentially a gadget designed for the purpose of making direct comparisons between two signals and displaying the resuts upon its CRT screen.

Fig. 5. shows how a scope operates; the electron gun produces a sharply focused beam of electrons which strike the phosphor coating of the screen. Wherever the electron beam hits, the phosphor glows. Two sets of deflection plates control the positioning of the beam. One set, the V plates, move the beam in the vertical direction, up and down. The other set, the H plates, move it horizontally back and forth.

In a general-purpose scope, both the V and H plates are driven by separate amplifiers so that small signals may be built up to the several dozens of volts strength necessary to produce easily-visible deflections. In some types of modulation-monitoring hookups, though, the plates are driven directly by rf signals.

If two different signals are applied to the two different sets of plates, the beam traces a path which is determined by the comparison of the two signals. For instance, one of the main uses of a scope in general service work is to examine a waveform. To do this, a sawtooth signal which increases linearly with time is applied to the horizontal plates. This moves the beam across the CRT at a constant speed from left to right, and causes the beam to fly back to the left when it reaches

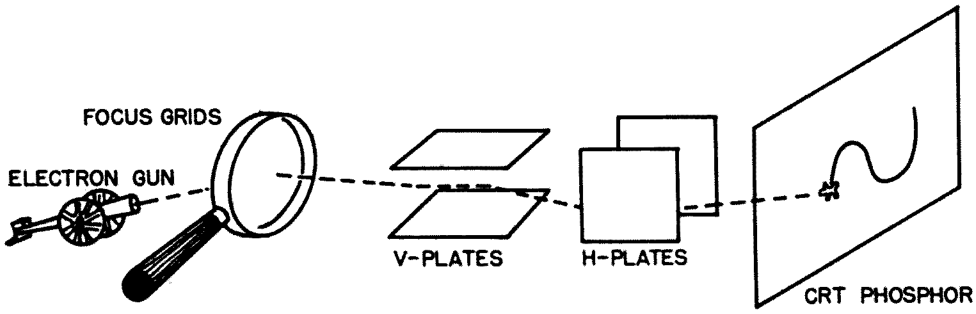


Fig. 5—Oscilloscope uses electrostatic (voltage-operated) deflection of focused electron beam to perform comparison. Beam is moved vertically by voltages on V plates, and horizontally by voltages on H plates. Phosphor makes beam visible when it strikes screen, and path traced by moving beam provides comparison of voltages on the two sets of plates.

the right edge. The signal to be examined is applied to the vertical plates. The beam then moves up and down in response to the signal being examined, and from left to right at a constant speed—and the result is, as shown in **Fig. 6.** a picture of the signal being examined.

If the sawtooth signal's frequency is exactly the same as that of the signal being examined, then one complete cycle of the test signal will occupy the full screen. If the frequency of the sawtooth is cut in half so that the beam moves just half as fast, two cycles of the test signal will be shown. This is illustrated in **Fig. 7.**

Since this is one of the major applications of a scope, almost all general-purpose scopes include a built-in sawtooth generator to provide the "internal sweep" signal for the horizontal plates.

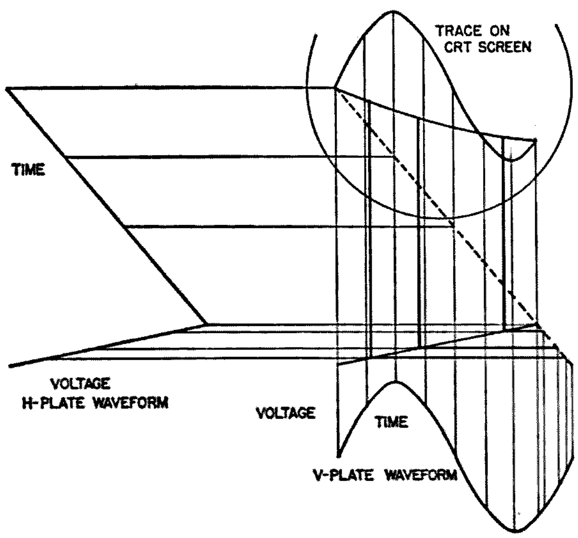


Fig. 6—Application of voltage with sawtooth waveform to H plates makes beam move across from left to right at constant speed (except for 'flyback' time, shown exaggerated here). Sine wave applied to V plates then moves beam up and down, reproducing waveform visibly on screen. H-plate waveform is turned on end in all these illustrations to show how it moves beam.

However, there's no requirement that only a sawtooth be used. If you want to compare two frequencies of sine waves, you can apply one to the V plates and the other to the H pair. The resulting display is called a "Lissajous figure" and can be used to measure frequency if one of the two input signals is a standard of known frequency.

Fig. 8. shows how the pattern is developed if both signals are of the same frequency. In this case the pattern may be anything from a straight line to a circle, depending upon the phase relationships between the two signals. If one of the signals is only a fraction of a cycle displaced in frequency from the other, the pattern will undergo a slow rolling, and this can be used to tell how far from the standard the unknown actually is.

If the unknown signal is twice the frequency of the known version, a **Fig. 8.** pattern will appear; this is illustrated in **Fig. 9. Fig. 10** shows the development of the pattern when the unknown signal is at three times the frequency of the standard, while **Fig. 11** shows only the pattern for the 4-to-1 ratio of unknown to standard.

If the unknown is half, one-third, or one-fourth the frequency of the standard, the same patterns will be displayed but they will be turned by 90 degrees.

Because of the way in which the pattern is developed, this technique produces a stationary pattern for *any* frequency ratio x/y if both x and y are whole numbers. That is, a ratio such as 8/9 in which the unknown is at 8/9 the frequency of the standard will produce a stationary pattern. Whenever the pattern is stationary, you can determine what ratio is represented by counting the loops

which appear along a vertical edge of the pattern and those which appear along a horizontal edge. The ratio of vertical loop count to horizontal loop count *is* the ratio of the frequencies.

When a scope is used to monitor modulation the technique is similar in many ways to the Lissajous-figure approach, but not identical. The modulated rf signal is applied to the V plates, and the modulating audio is applied to the H plates.

Whenever there is no audio, the carrier is constant. This produces vertical deflection, but without audio there is no horizontal movement of the beam and so the pattern is a vertical line in the center of the screen.

When audio is applied, the rf output swings to a maximum at one peak of the audio cycle, and to a minimum at the other peak. At the maximum peak, the vertical deflection is greater, and at the same time the horizontal deflection is maximum in the corresponding direction. This moves the beam to a corner of the display—and since the rf frequency is so much greater than the audio at this stage, the effect is a taller line at one side of the screen.

At the minimum peak, the horizontal deflection is maximum in the other direction and the vertical deflection is less because there is

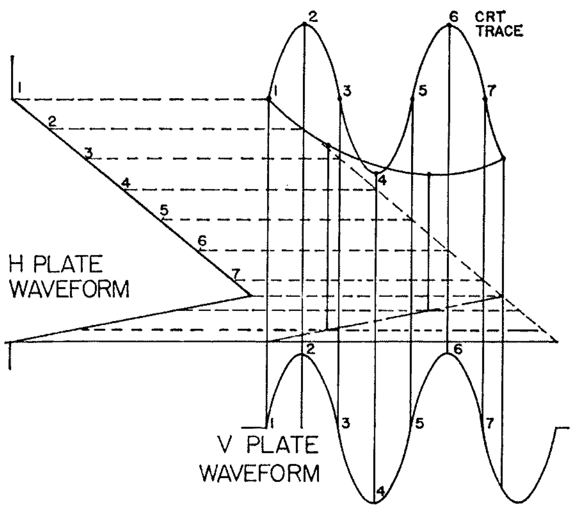


Fig. 7—If H-plate sawtooth frequency is just half that of the V-plate sine-wave, two complete cycles of the sine wave will be traced on screen rather than one. In practice, it's best to adjust H-plate signal frequency to ⅓ that of V-plate signal so as to display 3 complete cycles, since first and last cycles are usually slightly distorted by flyback effects as can be seen here in last part of second cycle. If 3 cycles are displayed, center cycle will be undistorted and complete waveform can be examined.

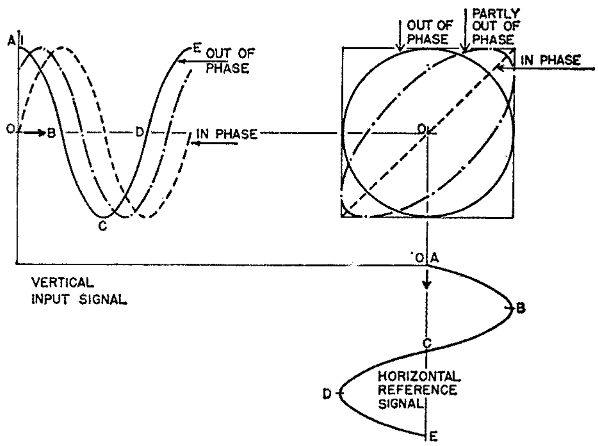


Fig. 8—When sine waves are applied to both V and H plates, patterns called "Lissajous figures" result. If both sine waves are at same frequency as shown here, pattern may be anything from straight line to perfect circle depending upon phase relationships of the two. In-phase signals produce diagonal line (1) *while 90-degree phase difference produces circle* (3), *phase differences between 0 and 90 degrees produce ellipse* (2).

minmum rf. The effect is a shorter line at the other side of the screen.

Since the audio signal is continuous between these two peaks, the beam also occupies all positions between these two extremes, and thus paints a "trapezoid" upon the screen.

If you haxe exactly 100 percent modulation, without distortion, the minimum peak will cut off before the audio signal reaches its a triangle coming down to a perfect point at the minimum-peak position.

If you have overmodulation, the rf output will cut off before the audio signal reaches its negative peak; the display then will be just like the 100-percent picture except that the left-over audio will produce a line sticking out from the point.

If modulation is less than 100 percent, the tip of the triangle will never be reached.

Fig. 12 shows how these patterns are produced, and **Fig. 13** illustrates the patterns developed by 25%, 50%, 75%, 100%, and more-than-100% modulation.

Note that all these patterns assume that the modulator is operating without distortion, so that the modulated signal is a faithful reproduction of the original audio. If distortion is present, the sides of the triangle won't be straight; instead, they will be curved. What this display actually amounts to is a picture of your modulator at work—and that's why it's so helpful.

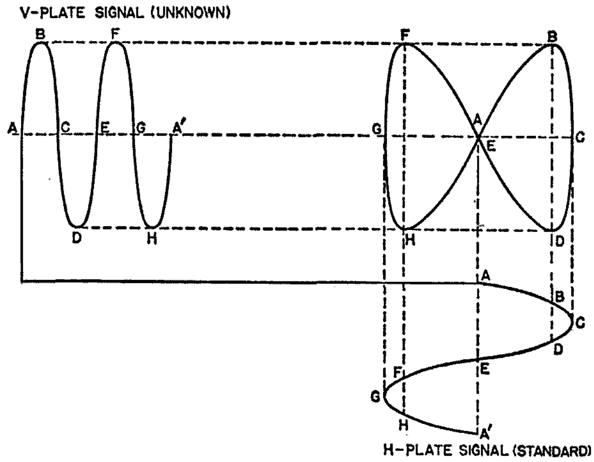


Fig. 9—When sine-wave signal of twice frequency of H-plate signal is applied to V-plates, figure-8 pattern is traced as shown here. Phase differences will rotate pattern; as pattern is moved, it gives illusion of being a cylinder with the pattern traced on the surface of the cylinder. Pattern for 2-1 ratio may resemble a U, if phasing is such that points D and H coincide on trace while A and C match. This happens when H-plate signal is 90 degrees out of phase with signal shown here.

The "bowtie" or two-tone-test measurement of SSB linear amplifier adjustment amounts to exactly the same thing as the trapezoid test for AM modulation. The only difference is that you get two patterns tip-to-tip on the bow-tie test; it's interpreted in just the same way.

The oscilloscope can also be used as a voltmeter, and is one of the best such instruments available for measuring ac since the comparison is direct and visual. The technique for using the scope as a voltmeter is simply to determine how much deflection is produced by a "standard" voltage, and then compare this to the deflection produced by an unknown voltage. The comparison can be made by measuring the length of the line produced by the deflection. A voltage which produces a line twice as long as the standard is a voltage twice as great as the standard. If the line is 74/100 as long, the voltage is 74/100 of standard. By proper choice of standard and line length, you can get greater accuracy by this method than by any moving-coil meter movement. Thus the scope can be used as either a direct or an indirect measuring instrument.

Most measuring instruments, though, are limited to one or the other of the modes. How can you tell which is which?

Any measuring instrument which includes the word "bridge" in its name is likely to be a direct-measurement device, while those which include the word "meter" in their names are more likely to be indirect devices.

A notable exception to this general rule is the "SWR Bridge; the instrument which originally bore this name actually was a bridge, and thus a direct-measurement instrument, but the original circuitry has long since been replaced in popularity by a directional-coupler- based hookup which is more accurately termed an SWR meter. The measurement is indirect.

How Accurate Can Measurements Be? The two points we've established so far about this business of measurement are (1) that any measurement is a comparison of an unknown quantity against a known standard, and (2) that most measurements we make are made indirectly rather than directly.

The next natural question is, "How accurate can a measurement be?"

It may not appear obvious that *no* measurement can be perfectly accurate, and that *all* measurements must include at least some margin for error—but it's true.

For a measurement to be *perfectly* accurate, the quantity being measured would have to be identical to the standard in every possible respect. If we were measuring

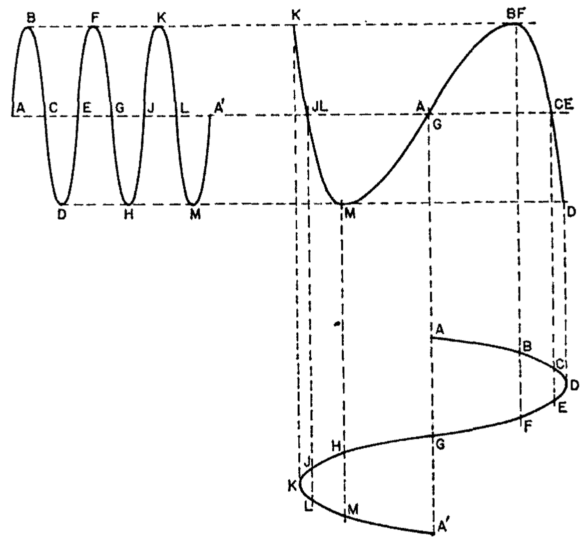


Fig. 10—At 3-1 ratio pattern is developed in this manner. Again, many patterns are possible at this ratio due to possible phase relationships; if either signal is offset in time from that shown here pattern will change as discussed in caption of Fig. 9. If pattern is made to rotate by slight adjustment of frequency to produce tiny difference from 3-1 ratio, number of cycles can be counted to determine which standard pattern is being displayed.

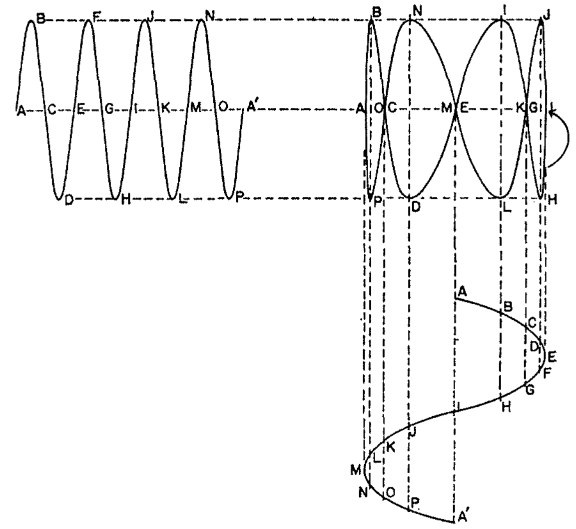


Fig. 11—This is one of the many possible 4-1 Lissajous figures. Any offset of either signal from time relationship shown here will change the pattern, but in all cases it will be stationary and will have four points at the top edge and four at the bottom, as does this one. Frequency ratio of vertical signal to horizon signal is same as ratio of number of top-or-bottom points to number of "side" points; all patterns shown here have only one "side" point.

weight, for instance, not only would the two have to match perfectly in the number of pounds and ounces represented, but *also* in the number of atoms represented, and even in the number of neutrons in the nucleus of each atom on either side of the comparison. What's more, if so much as a single cosmic ray were to hit one of the two items in comparison and not the other, then at least some part of the mass of the one hit would be changed to energy and the exact match would no longer be exact.

When you consider the number of elementary atomic particles involved in even the smallest practical standard of weight, and then hang on the requirement for exact matching of each and every one of these, you may not be outside the realms of theoretical "possibility"—but the probability of ever achieving such a match is vanishingly small. It's much more likely, for instance, that a monkey typing at random would produce the complete works of Shakespeare—and *that* is an event which has been calculated as likely to happen not more often than once in ten times the total history of the universe to date!

To continue this line of "unreason" a bit longer, just consider the practical question: How would you know you had such a match if you achieved it?

All the objections we've raised here to bring out the impossibility of a "perfect" or "zero-error" measurement of weight apply equally to any other measurement by comparison. The main point is that "zero" error means just that—no error at all—and an error by as little as one-fiftieth the diameter of a single electron is *still* an error.

While "perfect" measurements are not possible, it's not only possible but relatively easy to make "practical" measurements to any degree of accuracy you're willing to afford.

Our ordinary milliammeters and voltmeters, such as we use in most of our ham-radio measurements, are usually rated at "5 percent of full scale" accuracy. Many are rated at "2%" instead of "5".

If we want more accurate measurements than this though we can go to lab-quality instruments guaranteed to be within ½ of 1% of full scale.

And if that's not enough and we have several thousand dollars to lay on the line, we can use 5-place digital voltmeters and read voltages to a guaranteed accuracy of five significant figures. In terms of length, that's more accurate than one inch in one mile.

The major problem with the use of high-accuracy instruments such as these, incidentally, is being sure that their original calibration is accurate. After all, no measurement can be more accurate than the standard against which it is compared. To use five-

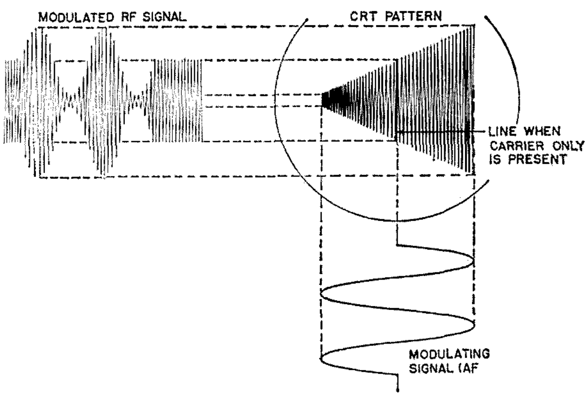


Fig. 12—Modulation-monitor pattern for checking quality of AM signal is developed in manner very similar to Lisajous figures as shown here. Pattern shown represents about 98% modulation (100% was not used in order to show how the negative-peak trace is developed). Audio signal should be taken from the modulator output, and RF signal sampled from the antenna feedline or antenna tuner, to get proper phase relationship and produce straight-sided patterns.

place accuracy, you must have a standard which is *more* accurate than five places.

While we're talking about accuracy of voltmeters and the like, it's a good time to establish just what that "5% of full scale" rating really means. Most of us tend to unconsciously assume that it means 5% of the indicated reading. If we read "100 volts" from the scale, we assume that the actual voltage is somewhere between 95 and 105 volts.

Actually, the 5% is "of full scale," and translates to an absolute error. On a 300-volt scale, the possible error would be 0.05 x 300, or 15 volts either way. On a 150-volt scale, it would be just half as much. On a 1000-volt scale, however, it would be 50 volts either way.

If we're using a general-purpose multimeter to make this measurement, most likely we are able to choose any of these ranges by simply switching to a new range. In this case, the *same* meter will have an absolute error of from 7.5 to 50 volts, depending upon the range which we select.

This is the reason for the general rule in making measurements: always make the measurement using a scale which brings the measurement as near to full-scale as possible without going off-scale with the reading. The purpose of the rule is to minimize error.

Voltages and currents are not the only things which we measure, however. Frequency is another item which we must, by law, measure rather accurately.

When we use a 100-kHz frequency standard to make our measurement, we're doing it more or less directly. If we use a beat-frequency frequency meter, we're indirect. In either case, though, we will always have some error. In a standard or direct measurement this error is usually discussed as "so many parts in 10 to the—th" which is engineeringese for mighty small parts of a percent and can be translated most meaningfully as "so many cycles per megahertz" or whatever. For instance, an error rated as "one part in 10^9" would be one Hz in 1,000,000,000 Hz, or one Hz in 1,000 megahertz. The standard frequency station WWV (about which we'll say more later) maintains considerably greater accuracy (less error) than this.

When our measurement is indirect, it's more usually specified as to error by a percentage rating such as 0.01 percent. This, too, can be converted rather readily to "x" Hz per megahertz or some similar approach. For instance, the military surplus BC-229 or LM heterodyne frequency meter is usually considered to have an accuracy of 0.01 percent when calibrated and operated in the manner originally intended. If you use this instrument to measure the frequency of a signal near the bottom end of the 20-meter band, around 14.0 megahertz, the 0.01 percent accuracy won't let you be certain that the reading you get is exactly the frequency of the signal.

But 0.01 percent of 10 megahertz is 1/10000 of 10,000,000 Hz or 1000 Hz, which means that the accuracy of our instrument is 1000 at 10 Hz or 100 Hz per megahertz. When we use it at 14 megahertz, our possible error is 1400 Hz.

The practical meaning of this uncertainty in our measurement is that we should assume that the band limit (in this case) is 1400 Hz *higher* than it really is at the low end, and 1450 Hz *lower* at the high end. Then if we measure a signal as being at our pseudolimit of 14.0014 MHz, it *must* be inside the band—because our maximum error would put it only at the actual bottom edge, not outside!

With the same instrument but in the 28-MHz band, we could measure band limits only to within 2800 Hz at the low end and 2970 Hz at the high end.

The important thing here is to remember that absolute accuracy in Hertz becomes less as the operating frequency goes up, since the percentage of error remains constant.

Can Measurement Affect Itself? Closely allied to the question of accuracy and error is the question whether the mere act of making a measurement can have an effect upon the measurement made.

Let's look first at the everyday variety of voltmeter. We've already discovered that it actually measures length instead of volts, and the length is related to the voltage by way of *power* which moves the needle across the scale.

Where does this power come from?

In the ordinary voltmeter, which has no internal power source of its own, there's only one possible place—from the circuit being measured!

But if we're drawing power from the circuit while we make the measurement, and not doing so when the meter is removed, then the mere act of hooking up the meter must involve a change in the circuit—and there's a

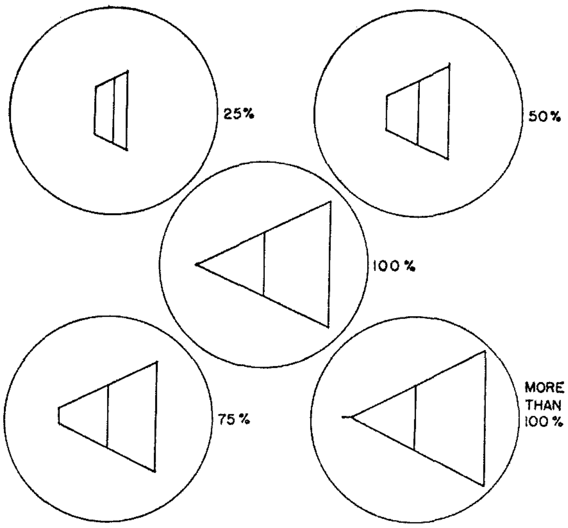


Fig. 13 Modulation percentage can be measured by these patterns, but it's easier to estimate it using these five examples. Overmodulation causes a 'tail' at point of pattern as shown; undermodulation prevents point from being developed. Controlled-carrier transmission will prevent line in center from being developed; it's the carrier-only line traced whenever modulation is absent from signal.

chance that conditions while we measure are *not* the same as those when our meter is taken away.

If you want to see how much change this may be, try measuring the AVC voltage of a receiver, using a 1000-ohm-per-volt voltmeter. No matter how strong the signal coming in, you will be hard-pressed to find more than a very small fraction of a volt in most such circuits.

The reason is that the 1000-ohm-per-volt meter has a total resistance of only 100,000 ohms if set to a 100-volt scale—but the series resistor in most AVC circuits is on the order of 5 megohms. The 100-volt meter acts as a 100 K resistor to form a voltage divider and reduce AVC voltage to 1/50 its normal value—or about ½ volt in most cases.

Using a 20,000-ohm-per-volt meter instead will help matters somewhat, but the effect is still rather large. Total resistance of this meter on a 100-volt scale would be 2 megohms, which is series with a 5-megohm resistor would reduce the voltage to 2/7 its normal value. This is still less than half the voltage present when the meter is removed.

Vacuum-tube voltmeters normally have extremely high input impedance, at least 11 megohms, regardless of the scale to which they are set. Using one of these on the same example AVC line, the voltage-divider effect would be only 11/11+5 or 11/16—but even with this meter the AVC voltage would be some 31% less with the meter hooked up than when the meter is absent.

Apparently, then, connection of any measuring instrument to a circuit will upset that circuit to some degree. This would mean, if taken to extremes, that even if *perfect* instruments were available and even if that impossible *perfect* measurement could be made, we would *still* have inaccuracy whenever we attempted to make an in-circuit measurement due to the effects of the instruments upon the circuit.

That's true. It's one of the basic principles of physics, known as the 'uncertainty' principle. No measurement can be exact, because the act of measurement in itself disturbs the quantity being measured and thus introduces error.

It works both ways, too. While the instruments upset the circuit, the circuit also can affect the instruments. A standard voltage source may be extremely accurate so long as no current is taken from it—but any load may ruin its accuracy.

The effect is particularly noticeable when making measurements of frequency. A frequency meter is not likely to have much influence upon the crystal or VFO in a good transmitter—but the transmitter's output signal may easily "pull" the frequency meter by a few cycles, and thus destroy accuracy.

If the instrument and the circuit are not connected to each other in any way, then neither can affect the other—but neither are you able to perform any measurements. If they are connected too well, each will affect the other in so great a manner that any measurements you make are inaccurate.

The answer to this seeming paradox is to connect them, in order to make measurements, but no more closely than is necessary to permit the measurement to be made. A frequency meter is normally coupled to the circuit under test only by incidental radiation in the room—this is enough, and any wire connection would be too much. Voltmeters, on the other hand, require wire connections.

When close connections must be made, as with voltmeters, the loading effects can be minimized by making the meter's internal resistance as high as possible so that it looks as much as possible like an open circuit to the device being measured. VTVMs, for ex-

ample, are designed specifically to provide extra-high resistance—and as we have seen even this is not always good enough.

But high internal resistance is not always a good idea for meters. Current meters should have as little resistance as possible, for example, since they should look as much as possible like a straight piece of wire to the external circuit.

What Are Measurement Standards? Throughout this discussion we've been talking about "standard" quantities and units, but we haven't yet seen where the "standard" comes from.

Actually, for any one type of measurement such as length, voltage, resistance, etc., the "standard" is entirely arbitrary. The important thing about any *one* standard is simply that everyone who uses it must agree that it *is* the standard, so that measurements made by one individual can be meaningful to anyone else. An example of the confusion which can arise when this factor is ignored is the "gallon"; in the United States, a gallon is four quarts, which is equal to 231 cubic inches of water. In Great Britain, however, a "gallon" is not the same. There, the "Imperial gallon" is the standard, and it is equal to 1.2009 U.S. gallons!

Another example of similar confusion is the "mile" which we use on land, and the "nautical mile" used at sea. The "pound" in Russia is only 0.90282 of our "pound"—and the "Troy pound" used by silversmiths contain only 12 ounces.

Many similar examples can be found in any good encyclopedia. A standard is "standard" only to those who accept it.

In radio and electronics, fortunately, the standard units are almost universally accepted by everyone. We work with quantities which are very closely related to the basic standards of nature, and when we agree upon standards for measuring those basics—time, and electric charge—the rest of our standards are completely fixed by the interdependence of all our quantities.

For instance, if the "volt" and the "ohm" are defined, then the "ampere" is also defined by Ohm's Law and no additional standard for it is necessary.

The most basic of all our standards is that of time. In this country, the time standard is maintained by the National Bureau of Standards and is made available to all through the broadcasts of station WWV.

These broadcasts are on frequencies at exact multiples of 5 MHz throughout the high-frequency spectrum, as well as one at 2.5 MHz; the ones most generally used are on 5, 10, and 15 MHz. The frequency itself *is* the basic time standard; by counting 10 million individual cycles of the 10-Mc transmission you have a "standard" second.

For user convenience, though, WWV does the counting and superimposes a "tick" on the signal at precise 1-second intervals. This "tick" consists of exactly 5 Hz of a 1000 Hz tone (also derived directly from the main standard), and the time standard is from the beginning of the first cycle of one tick to the beginning of the first cycle of the next.

For our purposes this is accurate enough, but for many more scientific uses the error introduced into the standard by the radio transmission path from WWV's transmitters at Boulder, Colo., to the receiving station is excessive. For these users, low-frequency transmissions at 60 kHz are made; at this very low frequency, transmission-path errors are minimized and frequency accuracy of one part in 1,000,000,000,000 are possible. This amount of error is approximately the amount represented by the thickness of a cigarette paper compared to the distance from earth to the moon. That's very close—but it's *not* exact!

Since frequency of a signal is simply the count of the number of cycles within a stated period of time, the standard for time is simultaneously the standard for frequency. Thus WWV provides a frequency standard against which we can all compare any signal we desire.

Other time standards are maintained by the Dominion Observatory at Ottawa Canada, through station CHU at 3.330, 7.335, and 14.670 MHz; by station MSF at Rugby, England, operating on 2.5, 5, and 10 MHz; by ZUO at Olifantsfontein, South Africa, 5 MHz; by JJV, Tokyo, Japan, 2.5, 5, 10, and 15 MHz, and a number of other governments. In addition to WWV, the NBS operates WWVH in Honolulu (which is slaved to WWV in such a manner that it's possible for you to receive both at the same time without interference).

In this country, our standards of voltage and resistance are also maintained by the NBS. Only one "primary" standard of each exists. From these, "secondary" standards are developed and all actual use involves the

secondary (or even more remote copies) versions.

The NBS primary standards agree with the definitions adopted by the International Committee on Weights and Measures. These definitions establish the "ampere" as an electric current which would produce between two conductors of infinite length and negligible cross-section separated by one meter distance in a vacuum, a force of 0.0000002 newton per meter. The "volt" is then defined as the potential which causes a dissipation of one watt when a current of one ampere flows, and the "ohm" as the resistance which permits one ampere to flow when one volt potential appears across it. The coulomb (unit of electrical charge) is similarly defined as the amount of charge transported in one second by a current of one ampere, while the farad and the henry are also defined in terms of coulombs, volts, and amperes.

These "standard" definitions may sound as if they go in a circle—to measure any one of them you must already know all the others. In practice, that's just about the case.

It *is* possible to measure the forces involved in the definition of an ampere and so determine a standard ampere directly—but since the ampere exists only while current is flowing, the standard ampere cannot be preserved to use as a comparison standard!

The procedure actually followed to establish a primary standard, as a result, is to build coils in such a manner that their inductance can be calculated very accurately and then to use these coils together with a standard one-ampere current to measure out standard resistances. The resistance standard, together with the current-measuring devices, permits establishment of a voltage standard.

The primary standard which result provide permanent references for measurement of both voltage and resistance; the current standard—which is the only one which can be established directly in the first place—is then derived from the voltage and resistance standards whenever it is needed.

If you want some exact figures for standards, the coulomb (which is the unit of electrical charge) is supposed to be the charge of 6,280,000,000,000,000,000 electrons, give or take a few million billion. The ampere is derived from this as the number of coulombs which pass a given point in one second. The ohm is defined by some as the resistance of a column of mercury at 0° C, having a length of 106.300 cm, a mass of 14.4521 grams, and constant cross-sectional area; the volt is then defined as the potential which permits one ampere to pass through one ohm.

For everyday purposes these official standards don't give us much help. Simply determining the basic standards accurately enough for any use is a most delicate and costly operation. Fortunately, there are many "standards" readily available which are accurate enough for almost all our uses.

For instance, you can buy resistors which are guaranteed to be 1% accurate for less than a dollar. If you need accuracy of 0.01% you can get this too, but it will cost a little more. For most ham applications, since our meters themselves are only 2% accurate at best, the 1% standards are plenty good.

A mercury cell is a pretty good voltage standard, since it produces 1.34 volts for essentially its entire life. In a pinch you can even get by with a *fresh* size D flashlight cell, which should produce 1.561 volts, but the voltage of these carbon-zinc dry cells varies with age and so they are not so trustworthy.

A zener diode offers another standard-voltage reference. While most such diodes are rated to only 5% accuracy, any one diode will have a constant voltage drop throughout its life if it is not abused, and so it can be used as a secondary standard once you have calibrated it against some more accurate primary standard.

The best frequency standard is a quartz-crystal oscillator which has been calibrated against the transmissions of WWV. However, commercial AM broadcast stations are required by law to remain within a 20 Hz of their assigned frequency, and you can use a VFO which has been zero-beat against a broadcast station to provide a reasonably accurate standard in an emergency.

The one item you should *not* use as a standard is a meter, no matter how costly or how accurate its rating. Meters are sufficiently delicate that any small shock can throw them off; their accuracy should never be trusted except immediately after they have been compared to some known standard. This process is called "calibration" and should be carried out at regular intervals for all meters, although almost none of us do so.

Next month. As our series draws toward its close, we'll move closer to the state of today's art and take a look at semiconductors. ■

More on Receiver Blocking

Strong-Signal Receiver Modifications

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The problem of the blocking of a receiver *if* by a strong, nearby signal, has been discussed.[1,2] Further experience indicates that a more-standard approach that applies equally well to transceivers, has some advantages.

In several types of equipment, there has been a spurious oscillation when a separate exciter uses the heterodyne crystal oscillator of the receiver, as must be done in the transceive mode. This oscillation may not be identifiable by others because it usually is not modulated. The only identification seems to be the coincidence of VOX action, which can be matched between the spurious and the true signal using two receivers. In one case, the oscillation was strong enough to prevent normal modulation.

With Collins S-Line in OPR (unmuted receiver) condition, the 6146 and linear amplifier plate current were noted to be above the normal static levels. Subsequent investigation disclosed an 8-tube oscillation, as follows:

The antenna relay K2 in "transmit" feeds a small amount of power to the receiver contact leaf. This is fed through the coaxial cable to the receiver antenna input. Then it goes through the rf stage, and to the first mixer. The cathode of the latter leads to T2, one side of which is tuned by the preselector knob. T2 also passes from the receiver through a coaxial cable, in transceive patching, to the "RCVR xtal osc input" of the exciter. This leads to the second mixer tube, the 6AH6, the 6CL6, and

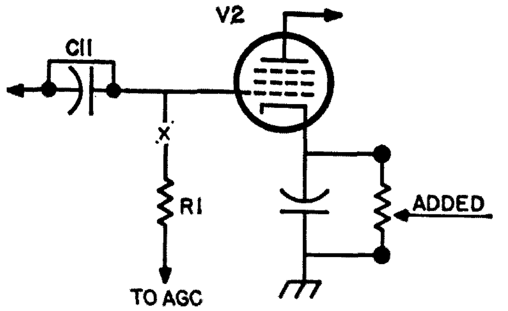

Fig. 1. Removal of AGC connection to prevent blocking of receiver.

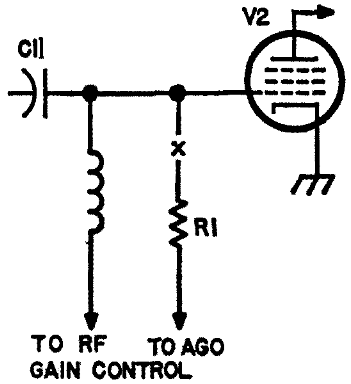

Fig. 2. AGC resistor detached from the grid and rf choke connected.

a pair of 8146's to the antenna relay, K2, completing the circuit.

In my equipment, the oscillation has been found only on the 21 and 28 MHz bands, when using a short 16-inch *rf* patchcord. This short cord is necessary to prevent the exciter from sucking out heterodyne crystal oscillator power, and making the receiver insensitive. The longer cable allows the oscillation only on one band.

If the receiving antenna lead is removed, or the rf tube pulled, or any other break made in this long circuit, the oscillation stops. In fact, the lower tube voltages used on CW also sometime confine the problem to the SSB mode.

Normally, the S-Line does not have this trouble when the receiver is muted in the STBY (muted) switch position. However, in order to prevent blocking of the agc by local stations, the shortening of the rf tube's grid capacitor, provision of cathode bias, and removal of the agc connection as shown in **Fig. 1**, meant that one less tube is muted. This allows a small amount of oscillation to continue in STBY position.

A good way to stop this was found to be possible, as shown in **Fig. 2.** The grid condenser of the *rf* stage is left in (or reduced

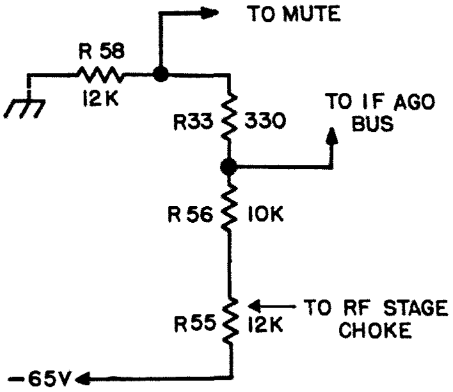

Fig. 3. Removing if stages from the rf gain control.

to 100 pF), the agc resistor is detached from the grid, and an 0.1 mH *rf* choke is connected to the grid. The bottom of this choke is connected to the arm of the *rf* gain control, R56. Now, muting is normal, and S-meter operation is normal—if you don't mind the rise in meter reading when the *rf* gain control is retarded.

There is a considerable loss in sensitivity (SN/N) when the *rf* gain control affects the *rf* stage. This had been stopped with the modification of **Fig. 1,** but is still present with the modification of **Fig. 2,** if the *if* agc bus is left connected to the arm of the *rf* gain control. I do not find any reason to use the *rf* gain control in the presence of fast-attack, slow decay agc, or without agc, on SSB, AM or CW. Therefore, it is attractive to leave the *if* stages off the *rf* gain control, and to use this control only for the *rf* tube. See **Fig. 3.**

This is easily done by lifting the correct black-red-orange (in my receiver) lead from the agc bus to the terminal strip forward of the coil cans, and to connect it to the negative end of the 330-ohm bias resistor, R33, on the next terminal. The *rf* choke lead from the *rf* stage then can be connected to the terminal leading to the arm of the *rf* gain control, R56.

Now, there is no longer any *if* blocking by nearby strong signals, the *rf* tube is muted normally, effectively preventing the round-about spurious oscillation in "Transceive" mode. The S-meter (which still needs a 100-ohm resistor across it whenever agc is removed from the *rf* stage) reads normally at all settings of the *rf* gain control.

There is no need for by-passed cathode bias in the *rf* tube, which had been added in the modification of **Fig. 1.** The 6DC6, 6FV6, 6BZ6, 6AK5, 6GM6, and other tubes can be used, whichever way the cathode and suppressor are connected to pins 7 and 2 of their bases. The most remote cut-off tube has some theoretical advantages, but *some* 75S-line receivers are more sensitive with the 6FV6, when properly realigned for the tube used.

It is well to keep in mind that maximum results may occur when the *rf* stage alignment is touched up with the normal antenna on the receiver; that the best sensitivity (SN/N) may not occur when the alignment is trimmed for maximum signal; and that the best sensitivity is not necessarily indicated by the tube giving the highest total gain. Those liking a "hot" S-meter and good sensitivity, will like the 6FV6.

. . . K6KA

1. 73 Magazine, December, 1967.
2. "Front-End Receiving Filters," by E. H. Conklin, K6KA. p. 14, *QST*, August, 1967.

Build Yourself a Relegator

Right! Build yourself a relegator. Relegate that danged buzz and/or hum out of your antenna relay to the limbo of unpleasant memories. Cure those jitters the maddening things are prone to become afflicted with without warning or reason, which turn you into a switch flipping, red eared, jitter nut yourself in trying to stop it while the QSO or message is hung up.

It is so simple that a pre-Novice could probably build it from the accompanying circuit diagram. Your junk box won't even miss what it takes to build this gadget. Furthermore your relay will love you for feeding it pure dc even though it is only half wave. In fact it won't even miss the other half; I'll guarantee you that.

Components for the conversion are: 1-200 PIV, 400-750 mil. Silicon diode (either the popular top-hat or epoxy); 1-25 mfd 150 volt tubular capacitor; 1-miniature 115 volt 6 watt lamp; and 1-500 ohm 10 watt resistor.

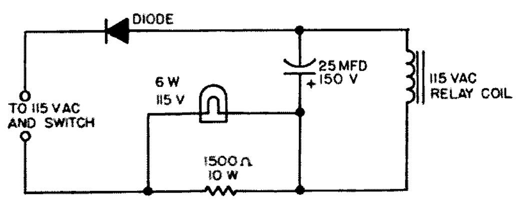

Fig. 1. *Diagram for converting a* 115 *Vac relay to dc operation at about* 40-45 *Vdc.*

Simply disconect the 115 volt ac source from your relay temporarily, and when you have the conversion completed and mounted right on the relay, that's generally the handiest place, again connect up the 115 volt ac supply through your regular activating switch to your new solid-state converter and you're in business; with an indicator light to boot, and 40 to 45 volts dc on your relay. What a relief!

. . . K6GRP

Transistor Regenerative Detector

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I've thought many times about some of the odd transistor regenerative detector circuits I see in the magazines. Very often they seem to have a certain unreal quality, and I've wondered if they really worked. Don't transistors make good regenerative detectors? They ought to, because their characteristics are far sharper than those of vacuum tubes. Yet the 1968 Radio Amateur's Handbook has no transistor regenerative detector circuits, and only one project. And that circuit, too, looks weird to me.

How about regenerative detectors?

Why are there so few regenerative detectors in transistor construction projects? Nobody wants them any more? No, I think there are more regenerative detectors in this country right now than at any time in the history of electronics. Good regenerative detectors offer better performance per parts dollar than any other circuit going, and I reckon those of us who must or want to build still outnumber the appliance operators. So I started some regenerative detector studies. First results were not too encouraging but as I continued thinking and building, consistent results emerged.

I developed a clear picture of how a regenerative detector should operate. We need to choose an operating point that is quite different from usual practice. Because the incoming signal is not strong enough to carry the base-emitter diode into cutoff part of the time, the detector cannot detect by straightforward rectification. We must have approximate square law detection, which reduces one side of the incoming signal and emphasizes the other side to bring out the audio. See **Fig. 1.**

Looking at this figure, we see transistor operating conditions are very important. The usual biasing standards emphasize linearity, which we do not want. The collector current must be very small so that downward collector current swings are limited but upward swings are not. If we have a large collector current the changes due to incoming *rf* will be so small compared to average current that negative half-cycles will not be appreciably different from positive half-cycles. It looks as though collector currents in the microampere range are appropriate.

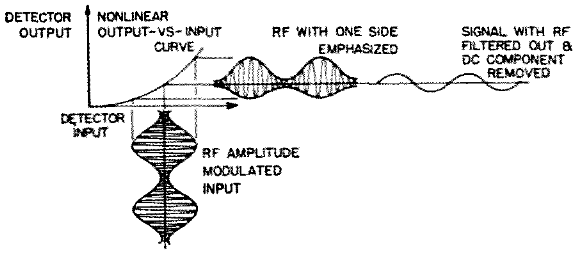

Fig. 1. If we operate the transistor detector at very low base and collector currents, its input-output characteristics are not linear. One side of the RF signal is emphasized more strongly than the other, producing a DC component that becomes our audio after passing through a coupling capacitor.

With this point secured, we think about the transistor's gain. Evidently it cannot be very good. At this point I almost convinced myself the reason there seemed to be no good transistor regenerative detectors was simply that transistors were inherently unsuited for the application. Yet I felt my picture was not clear enough. If the transistor offers enough gain for oscillation at *rf* is any more gain needed? Probably not, and I recalled again that transistor characteristics are maybe a hundred times sharper than the 01A I used in my first regenerative receiver. It seemed reasonable to suppose gain could be far less important than I thought.

At this point I built a regenerative detector circuit in breadboard style. It summed up my thinking about biasing and feedback control, and I felt quite confident until I turned it on. The result was an awful howl. Way off to one side of the regeneration control range there was a region where the detector worked, more or less,, but its sensitivity was notably poor.

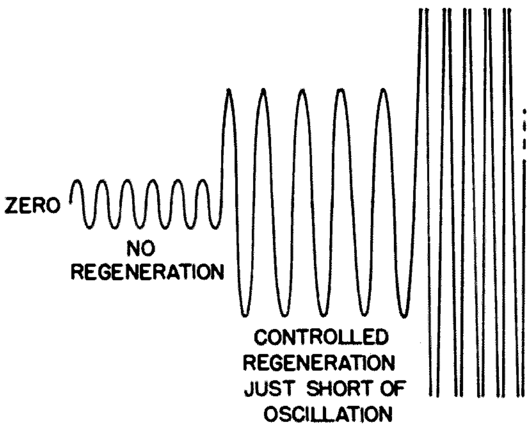

Fig. 2. RF feedback increases the RF voltage swing in the detector input circuit. Suppose we have a constant, very small RF input. As we increase feedback the voltage swing increases, even though the input voltage has not been changed. Too much feedback results in the uncontrolled-amplitude swings of oscillation, and detector sensitivity is reduced.

Thinking about the sensitivity control's sensitivity, I soon came to some conclusions. It appeared the control itself was in good shape, and the circuit design was reasonable on the basis of the factors I had taken into account. I realized I had missed a key point.

At the tiny collector current I had chosen, the transistor's *dc* beta was well below its normal value. This is a well-known property of transistors, which need a certain amount of current to become actively energized. My regeneration control acted to increase collector current and was also increasing the transistor's *dc* beta. At the critical point of starting to oscillate, the extra base current from the fedback *rf* would carry the transistor into a well-energized state, and it would stick there. It would keep oscillating til I turned the control way down, and at last the collector current would fall to a low non-oscillating value.

This kind of instability can be controlled by turning the transistor's current current gain against itself. We can ask the transistor to regulate its own base current, and if anything makes the transistor more lively, the regulation becomes more efficient. This is called feedback biasing and is very easy to arrange.

While thinking this through, I realized it is important to use a suitable transistor in the regenerative detector circuit. We cannot use just any old transistor that happens to be available. The best transistor will have a physically tiny structure for best operation at the tiny currents required, and for minimum circuit reaction. These properties are indicated by manufacturer's specs showing good beta at tiny collector currents, or perhaps by a collector dissipation rating of 50 milliwatts. I see General Electric's 2N3394, priced at 42¢ has a beta of about 50% of its best value at a collector current of 100 microamps. After looking at some other specs and making comparative tests on my Heathkit transistor tester, I concluded the 2N3394 is almost certainly one of the best inexpensive transistors for regenerative detector service.

I realized one other important point. The operating conditions appropriate for a transistor regenerative detector guarantee a very high output resistance. That is, the detector cannot develop a good signal voltage across the load typically presented by a transistor audio amplifier. The solution is to add one more transistor and a resistor, in addition to the components we would use anyway, as an emitter follower circuit.

Putting these considerations to work, I developed and breadboarded a new circuit. The results seemed to be very good.

Practical regenerative detector circuit

Here is the circuit I breadboarded. See Fig. 3. Operating into a handy Lafayette audio amplifier, it brought WWV in very strongly on 10 MHz. Several feet of test lead, draped over the top of the workbench, served as antenna.

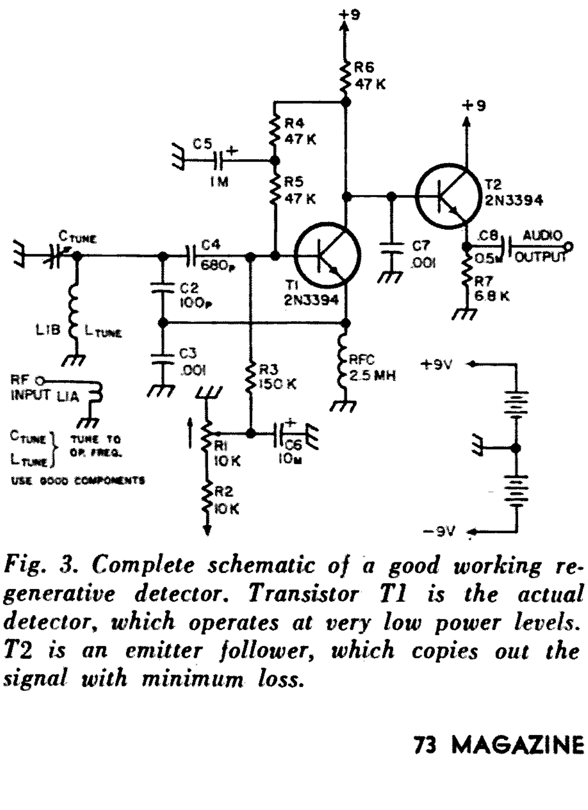

Fig. 3. Complete schematic of a good working regenerative detector. Transistor T1 is the actual detector, which operates at very low power levels. T2 is an emitter follower, which copies out the signal with minimum loss.

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Test Aid for Motorola FM Transmitters

Here's a simple gadget the FM addict using retired Motorola gear will find useful. Used in conjunction with a test set, the equipment can be used in its normal location, i.e., in the trunk, at its remote location, etc. If you've ever spent a cold night wrestling a rig out of your trunk to put it on frequency or service it, you'll appreciate being able to use the rig where it sits and get the procedure over with.

Materials are: 1 11-pin Amphenol male plug and 1 4-pin Amphenol mike connector. The hole in the cover of the 11-pin plug is enlarged to fit the mike connector. The wiring is done, and the mike connector is mounted in the cover, the cover snapped into place, and it's ready to make FM life a little easier for you.

Integrated Circuits Fundamentals and Projects

Rufus P. Turner's straightforward approach to integrated circuits opens with a discussion of what IC's are, and finishes with several simple projects easily assembled from available parts.

Chapters 1 and 2 introduce integrated circuits to the reader, who will be pleasantly surprised if he has been trying to work from some of the deep technical literature. There are several kinds of integrated circuits, and they are very versatile, but Turner's bread-and-butter approach gets the basic ideas over very well.

Each of the following six chapters discusses the construction and operation of a real IC circuit, easily assembled from parts available almost anywhere. None of the circuits require unusual voltages, and each is provided with photos, schematics and wiring diagrams. The well-chosen assortment includes a frequency-standard oscillator and an electronic voltmeter (using an easily-available 1 mA meter) as well as several audio circuits.

Available from Allied Radio. 75¢.

Now, here is the key idea. The base terminal of T1 regenerative detector is involved in a tug-of-war between two opposing voltages. Through R3, there is a constant dc voltage that is trying to turn off the transistor. Through R5, there is a variable dc voltage that is trying to turn it on. If we imagine the turnon voltage momentarily loses, collector current drops. T1 collector goes very positive and there is a strong return turnon signal through R5. And if we imagine the turnon voltage has momentarily won, the collector draws greatly increased current, collector voltage drops, and the available turnon voltage is reduced. This arrangement is known in scientific and industrial work as feedback biasing.

We adjust the interplay between these two opposing influences by varying the regeneration control R1, until we have just the amount of circuit liveliness we want. This will usually be just under or over the point at which the circuit goes into oscillation. And then the tug-of-war takes over, holding the transistor firmly at the critical operating point.

Two capacitors in this circuit deserve special attention. We want the regeneration control to have a good feel, and if it produces some contact noise we don't want to hear the noise. The large capacitor C6, tends to this. When the regeneration control is varied, the voltage across C6 follows it slowly. Noise is lost, and your ear has a better opportunity to hear what happened when you turned the control. This gives a clearer impression of effective control. And C5 prevents collector-to-base negative feedback at frequencies above a few tens of Hz. Without it, there would be signal as well as dc feedback, and this would kill the operation of the circuit. Since both are acting as bypass capacitors their values are not critical but values over ten times larger than shown won't do anything for the circuit operation.

At *rf* frequencies, the detector circuit is simply a common-collector oscillator. Feedback is from emitter to base, and looking at C2 and C3 we see that emitter and base are at nearly the same *rf* potential, as they would need to be in a low-impedance transistor circuit. You could try eliminating three components by tapping the emitter up on L1B, which would take out C2, C3, and the rfc. Next time I build the circuit I think I'll try this. And I noticed some influence of the

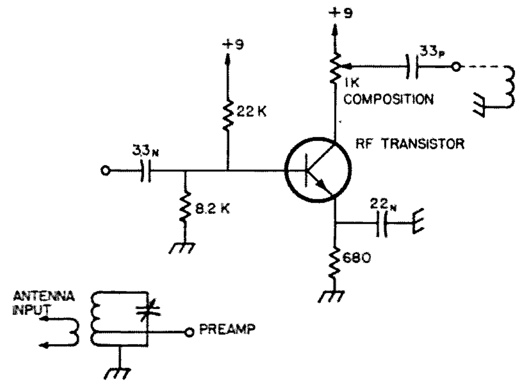


Fig. 4. The regenerative detector circuit can be coupled directly to an antenna, but this should give better results. The gain control reduces signal strength, for strong signals which try to take control of the detector. Its performance will fall off above 10 MHz even with very good transistors, but I think it will get by up to 30 or 40 MHz.

tuning control upon regeneration control setting, but this was not troublesome. A tapped coil circuit might reduce this.

Transistor T2 is the emitter follower output. Since the base terminal does not have to be at any particular potential so long as other components and voltages are appropriate, we can hook the base directly onto T1's collector. I provided C7 to keep T1's collector at *rf* ground, which is required for good *rf* performance. And it avoids transferring *rf* into the following audio stages.

Why bipolar voltages? That is, plus and minus supply voltages? Well, that is because it is the easiest way to make this circuit. It goes back to that tug-of-war effect which stablizes the regeneration at a naturally unstable point. The transistor emitter needs to be held at a fixed dc voltage, and ground voltage is most convenient. Then, if we are to have workably sized resistors in the base circuit, which is at about ground potential, we have to have a far-negative voltage to work from. You could try putting the emitter voltage up a few volts on a zener (suitably bypassed for *rf* and audio) along with a higher positive supply voltage, and if properly done it would work as well as what I have here. I merely chose the simplest easy way to make the circuit.

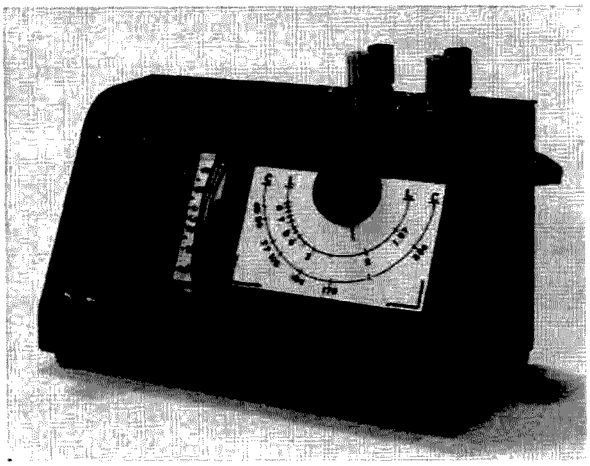
Application

My regenerative detector circuit seems to give as good performance as you could want, operating directly from an antenna. But like all regenerative detectors, it will respond to changes in loading and input signal strength. Here's a simple circuit you can try as an *rf* front end. See **Fig. 4.**

It's not designed to be efficient. If you want something better there are lots of ideas around in the amateur electronics books and magazines. I designed this to get by without any critical parts or transistors. Use any transistor you can find (but be sure to use correct polarity supply,) and see what happens.

The gain control in the transistor collector circuit is for use when signals overload the regenerative detector. Turn the control away from the transistor collector connection, and the signals will become weaker. If there is cross-modulation, or you want to try for better sensitivity, add a tuned circuit at the input as illustrated. Good luck with my new circuit! . . . W1EZT

"Q", "Q", Who Got "Q"



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How good are your coils? "Q" a figure of coil "merit" can be easily measured with a simple instrument. If we know our "Q's" (no "P's") maybe we can have less phone calls about TVI, BCI and HFI with a bonus of better efficiency in the rig, hence a better signal.

Until now very little has been mentioned in amateur articles regarding the "Q" meter and its application and construction. The "Q-Q" can be built for approximately twenty bucks (American money) or for five dollars if your buddy has lots of parts.

The "Q-Q" operates on the principle of resonance. To obtain this resonance, two conditions must be met: (1) there must be a circuit capable of resonance, (2) there must be a signal to which the circuit can resonate.

The block diagram **(Fig. 1)** shows the basic parts of the "Q-Q". The oscillator provides the signal and calibration voltage. This calibration voltage is applied to the tuned circuit through a 100:1 voltage divider. This voltage (let's call it drive voltage) is amplified by the tuned circuit at resonance; detected and measured on a voltmeter.

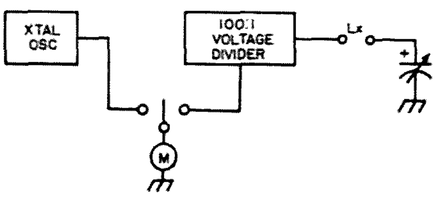


Fig. 1. Block diagram of "Q-Q"

In operation, a small voltage (E_1) is introduced in series with a tuned circuit, the unknown coil and C_3. The circuit is then tuned to resonance and the voltage (E_2) developed across the tuned circuit is measured on the voltmeter. The measured voltage E_2, is then compared to the driving voltage E_1. The Q of the circuit is then the measured voltage divided by the drive voltage.

$Q = E_2/E_1$

Thus a driving voltage of 1 v using a 100 to 1 divider for E_2 at resonance of 1 v gives a Q of 100. Any losses in the resonant circuit will result in a lower Q reading. In general, the losses in the coil are much greater than the losses in the other circuit elements. Thus the Q of the circuit is the Q of the coil for all practical purposes.

The battery powered "Q-Q" Meter (shown in **Fig. 2**) uses only three transistors, one as crystal oscillator and calibration source, the other two as a high-impedance voltmeter, Use of a crystal-type oscillator provides a more stable and less complicated circuitry than a variable oscillator, although a tuneable oscillator is used in the lab type Q Meter. Later in the article we will show you how to adapt to a tuneable oscillator which allows us to measure Q at the operating frequency. Crystal switching can be used if necessary. The stability of the crystal oscillator also allows the calibrating voltage and the drive voltage to be used directly without the use of emitter followers to isolate the load from the oscillator. The current drain is only 1.5 mA so battery life should be no problem.

Building the "Q-Q" is simple, although good rf construction should be followed, i.e., short signal leads and common rf ground.

The tuning capacitors must have very low loss insulating material used in its construction. Ceramic, Rexlite, or Teflon insulation is preferred. The fiber board used in the ordinary broadcaster capacitor, while usable in

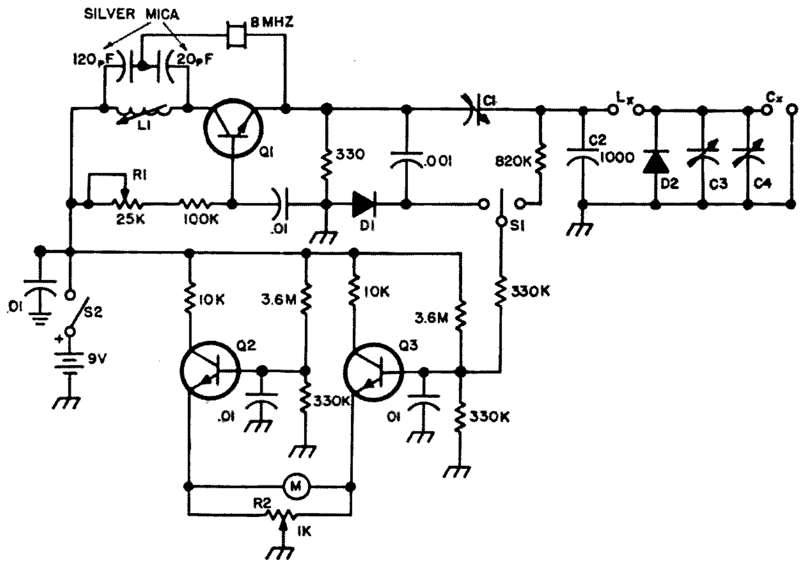


Fig. 2. Schematic diagram of the battery powered "Q-Q Meter."

a Pi network (where the in circuit Q is around 10-20), definitely has too much loss for this application. Many surplus capacitors with low loss ceramic insulators are available and one with a vernier drive is to be preferred. The one used here is a J. W. Miller #2111 with the fiber insulators removed and 4 small ceramic standoffs (similar to cambion #3848-2) added to support the stator. Capacitor C_4 is a surplus type CT15 modified to two stator and one rotor plate. The meter is mounted by a tight fitting hole in the front panel and a dab of rubber cement between a corner of the meter and the chassis. The terminal binding post should be mounted on a good insulator such as Lucite and mounted under a cutout at least ¼ inch larger than the post dimensions, to reduce stray capacity. Also use heavy bus wire (#14) or brass strap to keep the inductance down in leads connecting the binding post and tank capacitor together. Diode D_2 is mounted directly in the L_x binding post to ground. Capacitor C_1 is mounted on a small terminal strip near L_x binding post. The crystal oscillator and voltmeter circuitry are built on a piece of vector board using flea clips and point-to-point wiring.

Now that we have the "Q-Q" Meter built, let's calibrate it. Rotate Cal-Q switch to Cal. Turn R_1 to turn meter on, adjust R_2 to Zero meter. If meter cannot be zeroed, check wiring for errors. There should be no problem as this is a very straight forward dc amplifier. After zeroing meter, rotate Cal-Q to Cal position, adjust oscllator coil slug (L_1) for maximum on meter, then turn slug slightly into coil so oscillator starts in application of power every time. Adjust R_1 (set level) control for 50 μA on meter. This reading of 50 μA is used as the reference set Call level on the meter for all future use of the instrument and may be marked on meter face.

Now for calibration of L-C scales and Q Meter face. With a coil (tapped per **Fig. 3**) connected across the unknown L_x terminals switch to "Q", zero meter, rotate C dial knob (C_3) for peak on meter with vernier tuning (C_4) set at mid capacity. Record μA reading on meter VRS Q of standard coil also mark values for L and C on L-C dial plate. Using the A to D taps on the standard coil, connect resistors in parallel across the unknown (L_x) binding post, to complete calibration of meter face using Q values versus resistance in **Fig. 4.** After calibration appropriate marking may be made by transfer

TURNS	TAP	Q	C$\mu\mu$f	Lμh
7	A-B	135	256	1.57
13	A-C	210	106	3.8
18	A-D	235	69	7
23	A-E	260	50	8
6	B-C	120	310	1.28
11	B-D	180	134	3
16	B-E	215	69	7
10	C-E	170	151	2.62
11	F-E	195	120	3.35
16	F-D	230	77	5.2
21	F-C	280	55	7.4
27	F-B	275	39	10
34	A-F			

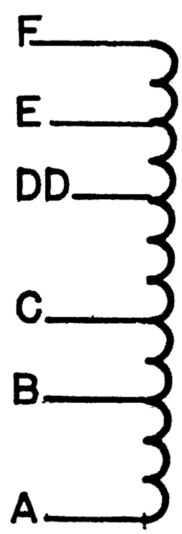


Fig. 3. See text.

	Q	R
A-D	= 235	= 0
	= 165	= 220k
	= 145	= 150k
	= 140	= 100k
	= 110	= 68k
	= 104	= 56k
	= 90	= 47k
	= 85	= 33k
	= 57	= 22k
	= 39	= 15k
	= 25	= 10k

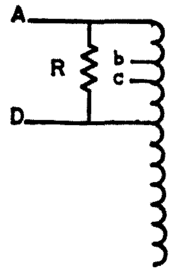


Fig. 4. Q values vs. resistance

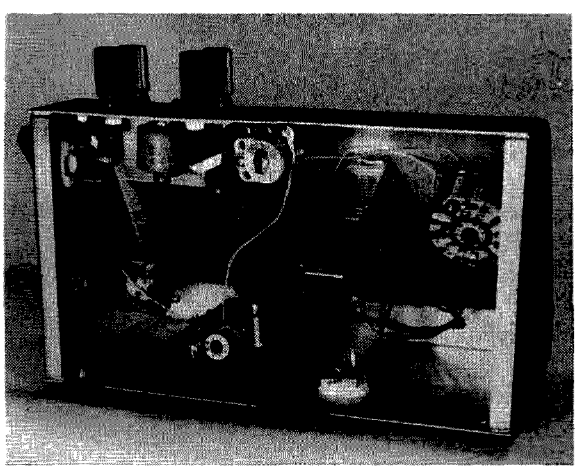
letters or pen and ink. The intermediate points may be marked by interpolation.

The standard coil has been measured on a Marconi #1245 Lab "Q" Meter and of 5 coils built and measured, the tolerance spread was less than 3 per cent maximum between coils. With reasonable care in tapping the coil and calibration one can have an instrument with 5 per cent of lab equipment.

The true experimenter may not be satisfied with the fixed frequency used in this unit, so if you have a good rf signal generator, it can be pressed into service as a VFO for this unit by changing Q_1 to a common emitter amplifier as in **Fig. 5.**

When using the external signal source (VFO) this unit will work very satisfactorily up to 25.2 MHz, with a degrading of 15-20 per cent for "Q" above 200, in the range of 15-50 there is no error measurable at this frequency. Standard frequency for measuring "Q" are 25.25 MHz, 7.95 MHz, and 795 KHz and for inductance values of .1-1 μh, 1-10 μh, and 10-100 μh, respectively.

The following procedures may be used as a guide in operation of the "Q-Q" Meter:



Interior of the Q-Q meter.

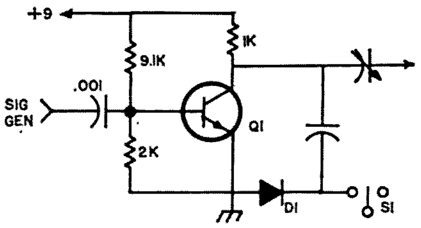
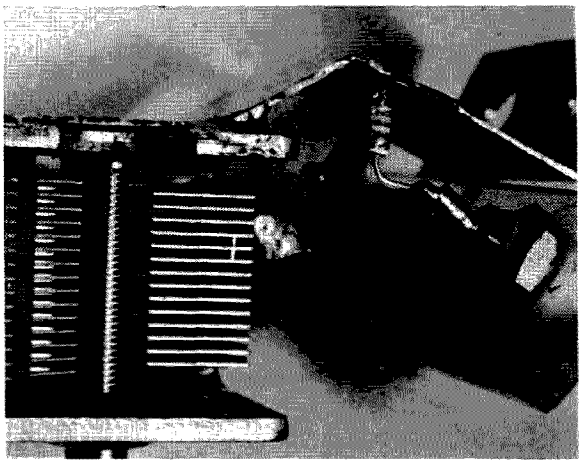


Fig. 5. Common emitter amplifier.

To measure the inductance of a coil:
- Set the Cal-Q switch to Cal.
- Connect the coil to the L_x terminals.
- Adjust R_1 to Cal (50 μA).
- Set the Cal-Q switch to Q.
- Set tuning (C_3) to max counter clockwise.
- Adjust R_2 for Zero on meter.
- Adjust tuning (C_3) for max indication on meter.
- Read the inductance on the L scale.

To measure the Q of the coil:
- Set the Cal-Q switch to Cal.
- Connect the coil to the L_x terminals.
- Adjust R_1 to Cal (50 μA).
- Set the Cal-Q switch to Q.
- Set tuning (C_3) to maximum counter clockwise.
- Adjust R_2 for Zero on meter.
- Adjust tuning (C_3) for maximum indication on meter.
- Read the Q of the coil on the meter.

To measure capacity by substitution:
- Set the Cal-Q switch to Cal.
- Connect a test coil across the L_x terminals.
- Adjust R_1 to Cal (50 μA).
- Set the Cal Q switch to Q.
- Set tuning (C_3) to maximum counter clockwise.
- Adjust R_2 for zero on meter.
- Adjust tuning (C_3) for maximum indition on meter.
- Note the value on the C scale as C_a.
- Connect the unknown condenser across the C_x terminal.
- Switch to Cal and check Cal level.
- Switch to Q.
- Adjust tuning (C_3) for maximum indication on meter.
- Note the value on C scale as C_b.
- The unknown capacity added across the C_x terminals is found by subtracting the C_b value from the C_a value. $C_x = C_a - C_b$.



Inside view of mounting of diode and straps connecting the binding posts to the capacitor.

Now that you have the L, C, and Q of a coil, you may wonder what is its parallel resistance? Without going deep in theory, we may use the relationship:

Parallel Resistance, $R_p = 2\,\pi fLQ$

or $R_p = w_oLQ$

where L = measured value

Q = measured value

$w_o = 2\,\pi f$

Therefore @ 8 MHz,

$w_o = 2 \times 3.1414 \times 8 \times 10^6$

$= 50.04 \times 10^6$

Let's keep this value of $w_o = 50.04 \times 10^6$ as a constant factor for further use. As an example, let's find the R_p at tap A-B in **Fig. 3.**

Tap	Q	Cμμf	Lμh
A-B	235	69	7

From above $Rp = w_oLQ$

$= (50.04 \times 10^6)(7 \times 10^{-6})(235)$

$= (50.04)(7)(235)$

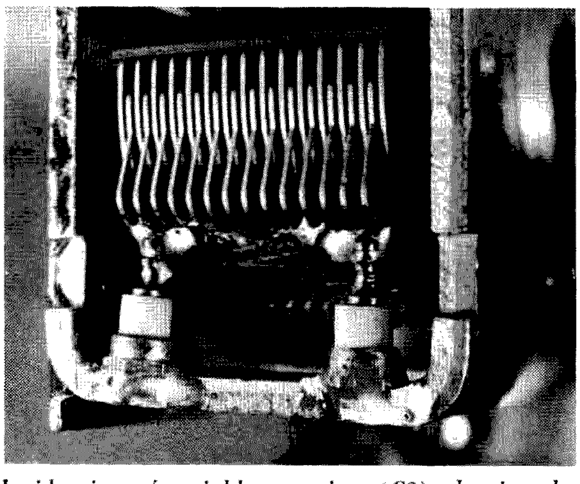
$= 82{,}250$ ohms or 82.2K

for tap A-C, $Rp = (50.04)\ (3.8)\ (210)$

$= 39.$K

and for tap B-D, $Rp = (50.04)(3)(180)$

$= 12$K



Inside view of variable capacitor (C3) showing the two ceramic standoffs for support of the stator.

The above examples stress the need for high quality components used in the "Q-Q" meter, as all losses are charged to the coil and would give much lower readings than expected. These examples are by no means all the "Q-Q" meter can do. This meter, (with pencil, paper, and a little work) can be used in the initial design of Transmitters, Receivers and Converters or just about any thing using rf, coils, and condensers.

It is hoped this article will stimulate the building of the "Q-Q" meter and in future articles we read, instead of saying 17 turns of wire removed from a surplus choke, wound on a ¼" slug tuned form, will call for 17 turns of #30 Enameled wire close wound on a ¼" slug tuned form with an unloaded Q of 30. Come on fellows let's get with it!

. . . WB6IBS

"Good grief, Betty! Can't we come back later for your ham equipment?"

Save That Cordless!

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The age of the cordless electric appliance is upon us. Anything from a $5.00 flashlight to a $60.00 drill can be obtained with a built-in battery and charger, and the list includes such "essentials" of modern life as electric slicing knives and electric toothbrushes. Sooner or later some of these gadgets quit working and wind up in the trash can. The purpose of this article is to point out to hams that they can be a source of useful and unusual parts.

The diagram of a typical cordless appliance is shown in **Fig. 1.** In this diagram B is a nickel-cadmium cell, or a battery of such cells, which is the heart of the device. The useful load (flashlight bulb, or whatever) is represented by R, and the switch is used to turn it on and off. The charging circuit consists of the Capacitor C and the bridge rectifier assembly CR1 through CR4.

The total voltage of the battery B is usually just a few volts, considerably less than the 115 V 60 Hz power used for charging. As a consequence the rectifier operates under current-limited conditions, that is the charging current through the battery is practically the same as the rectifier short-circuit current. This current is determined by the electrical size (capacitance) of the capacitor C.

A capacitor of 1 μF has an impedance at 60 Hz of 2650 ohms, and if connected across the line would draw a current of 43 mA. Allowing a little leeway for the various tolerances a 1 μF capacitor will produce a charging current between 40 and 45 mA. Smaller capacitors will produce lower charge rates, and vice-versa. Of course the charge rate is directly affected by the line voltage and frequency. Another way to look at it is to assume that the capacitor charge reverses with each reversal of polarity of the line, whereupon the capacitor "dumps" a quantity of electricity equal to twice its charge through the rectifier and into the battery.

Most of the smaller cordless appliances are not made to be repaired and are sealed tightly in plastic housings. The housing protects the user from shock hazard and reduces any danger which might exist from exploding cells, but does nothing to facilitate our access to the contents. While the bolder readers may wish to attack the housing with hammer or vise, a more cautious approach using a hacksaw is suggested. Usually it is possible to make a series of shallow cuts completely encircling one end so as to get at the insides without damage. At this point I would like to say that in my opinion it is not worth the trouble of opening the device carefully with the idea that it can be repaired. If you are cutting into an expensive appliance you may think otherwise.

The first cordless device I opened was a flashlight. This had been received as a Christmas gift and had quit before Valentine's Day. Since return would have embarrassed the donor, the thing lay in the workbench drawer for two years before I faced up to the problem. Since I make it a policy to break open all defunct capacitors, transistors, etc., to see what gives, I had to cut into the flashlight before consigning it to File 13. The circuit was as shown in **Fig. I.**

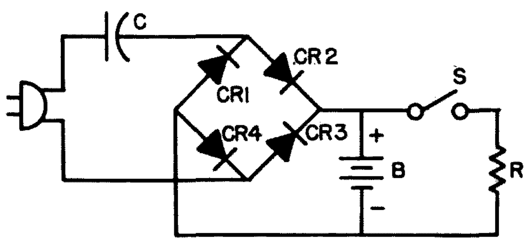

Fig. 1. Typical circuit for a small cordless appliance.

The battery consisted of two cells in series, each marked "250", which seems to be the capacity in milliampere-hours. The charging capacitor was 0.325 μF. The rectifier was a pellet about the size of a pea. One Ni-Cd cell was defective and all other parts were good. The charger charges the single good cell at 16 mA when connected across my power line (which reads a little over 120 v). After discarding the lens and housing I wound up with the following usuable parts:

1 Slide switch
1 Lamp bulb
(The parts mounted on an ac plug and suitable for re-use as is)
1 Capacitor, 0.325 μF, 200 v dc
1 Bridge rectifier
1 Ni-Cd cell, 250 mA

The next victim on my list was an electric toothbrush. The original had been purchased from one of the big chain stores. In a few weeks the brushes began sticking in the chuck and finally the shank of one broke off inside. The dealer exchanged the entire machine for a new one. This one ran for a couple of months before it got tired and wouldn't brush any more. Back to the store and we acquired unit #3, free of extra cost, of course. When it failed after a few months the wife tossed it in the wastebasket and forgot the whole idea of brushing teeth electrically.

When the toothbrush was opened the rectifier was found to be defunct. This rectifier also was a small pellet. It was cracked open and found to contain four rectifier plates, possibly selenium, each about 3/16" in diameter. Otherwise the toothbrush yielded the following parts in good condition:

1 Capacitor, 1.0 μF 250 v dc
1 Motor, Pm dc, 1.4 v at about 1 ampere
1 Ni-Cd cell, capacity estimated at 700 mA

To an experimented the potential utiliy of parts such as these should be obvious. The batteries do not supply a lot of voltage, but the voltage requirements of transistor and IC apparatus are decreasing. Many modern circuits are designed to operate around 3 volts and will operate satisfactorily from a single cell if the highest performance is not needed.

More discussion of the charging circuits may be in order. Note that in a circuit like **Fig. 1,** neither side of the battery is conconnected to either side of the power line. This means that neither side of the battery can be grounded while under charge. If a circuit like this is used in home-built apparatus care should be taken to disconnect the battery from any exposed loads before charging, and to make certain that yon do not contact any part of the circuit while it is turned on.

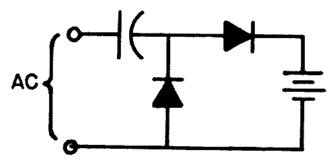

Fig. 2. Simplest charger.

Fig. 2 shows an alternate charging circuit which permits one side of the battery to be grounded. In this circuit half of the current bled from the ac source is shunted to ground through one of the diodes. For this reason the circuit charges the battery just half as fast as the circuit of **Fig. 1** would for the same size capacitor.

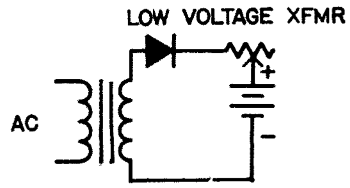

Fig. 3. Safest charger.

The simplest and safest circuit is shown in **Fig. 3.** This requires a transformer for isolation and protection, and may require some experimentation with the resistor to get the desired charge rate.

If the protection afforded by an isolating transformer is desired but no suitable low-voltage transformer is available, the circuit of **Fig. 4** may be of interest. This is a combination of the **Fig. 2** circuit and a high-

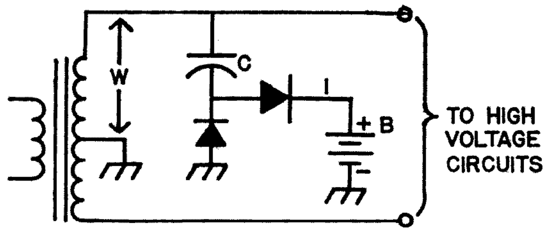

Fig. 4. Charging from a high-voltage transformer.

voltage transformer. Since the current required to charge the battery is small compared to the currents normally found in tube-type apparatus, it would be reasonable in some cases to use the secondary of a power transformer for this function. If the secondary voltage is above 115 volts ac, it will be necessary to reduce the capacitor size to get the desired charge rate.

An interesting point arises in connection with the voltage ratings of the components used in the circuits of **Figs. 1, 2** and **4.** Of course the capacitors should be rated for

continuous service at the peak voltage encountered. Just to play it safe use a capacitor rated for at least 200 v dc on a 115 v ac circuit. The rectifier PIV rating is a bit more involved: so long as a battery is connected and drawing current the rectifier diodes are subjected only to potentials not much greater than the battery voltage. In other words, the battery and the conducting diode (s) hold down the voltage across the non-conducting diode(s). The situation is drastically different if the charger is operated without load. Under this condition there is no current drawn, and the reverse voltage applied to the diode(s) may approach the peak of the ac line voltage. So we have a situation rather the reverse of that usually encountered: these circuits are not harmed by normal loads, and are not harmed by operating into a dead short-circuit, but if low-voltage rectifiers are used they can be ruined by being operated with no load. The solution is obvious: either use high-voltage diodes or don't operate the charger without a load.

The writer does not qualify as an expert on the care and use of Ni-Cd cells, and cannot give complete instructions on the subject. The following abbreviated instructions may warrant consideration by those with no experience at all along this line:

1. The voltage of a single cell ranges from about 1.1 volts when discharged to about 1.4 volts when fully charged.

2. Leaving cells discharged in storage, especially with a load connected, does not extend their life. Despite this no cell should be discarded just because the output is below 1.1 volts before charging.

3. The capacity in milliampere-hours is sometimes marked on the cell. Unmarked cells frequently can be identified by looking up the physical dimensions in a catalog. Some of the radio mail order companies list enough information in their catalogs to make identification possible.

4. Most of the chargers charge the cell at somewhere between the ten-hour rate and the twenty-hour rate, that is, the charging current in milliamperes is between 1/10 and 1/20 of the capacity in milliamperes-hours. This information can be used to design a charger for a cell of known capacity, or conversely, to estimate the cell capacity from the size of the charging capacitor.

5. Cells contain a caustic electrolyte. Leaky or broken cells should be discarded in a place where children and pets cannot get at them. Wash the hands after handling and make certain none of the electrolyte gets in the eyes.

6. Cells can explode, but it seems to happen rarely. I have had just one go up on me and it was a defective cell of high resistance which I was trying to force charge with a charger bigger than the one included in the original device. It made a sharp crack like a firecracker but did not spew its contents about. If the cell capacity and the charging rate are known, overcharging can be avoided by discharging the cell fully before commencing charging, then charging just long enough to put in the rated capacity plus 20% or so. Probably it is safest to remove the cell from any delicate equipment in which it is used before charging.

7. The potential shock hazard of any transformerless charging circuit should be recognized. Note that the manufacturers who use these circuits nearly always seal the apparatus so the user cannot contact any part of the circuit while it is plugged into the ac line.

. . . W3GKP

Building a Two Meter Ground Plane

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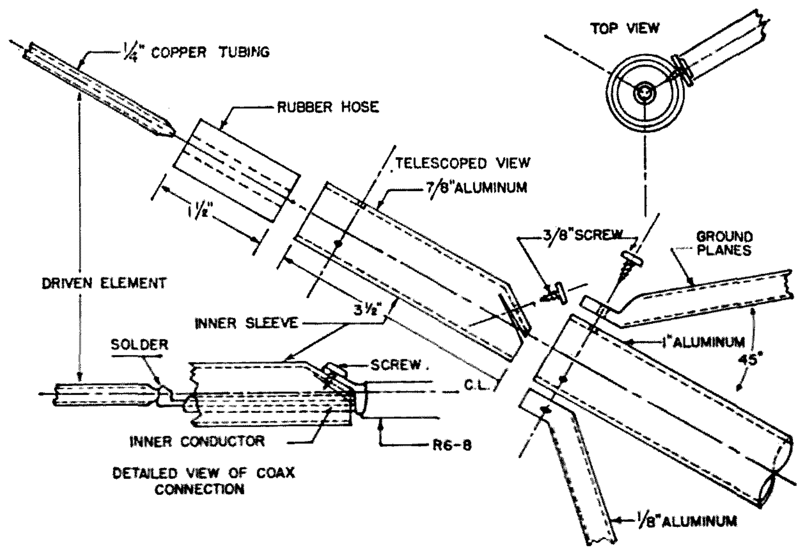

The simple ground plane antenna has long been a standard for simplicity, low cost, and dependability on the two meter band. If you are just getting started or are contemplating setting up a two meter station, the ground plane should be your first consideration for an antenna—especially if you are planning on participation in a net where a nondirectional antenna is desired. Granted, the ground plane offers no gain as you would expect from a beam or yagi antenna, but the ground plane need cost you very little, and will work effectively until you get a more exotic installation. This article will cover none of the theory involved; most hams will be eager to get on the air now and ask questions later. So, if you want an effective two meter antenna that will cost you very little, read on.

This whole idea resulted from the following three conditions:

1. A burning desire to get a two meter antenna installed quickly with no cost.
2. Holding a short piece of ⅞ inch diameter aluminum tubing in my right hand.
3. Holding a piece of one inch tubing in my left hand.

It soon became evident that the ⅞ inch tubing would fit inside the 1 inch diameter tubing, and very shortly after this, the idea of making the antenna completely coaxial evolved. A quick glance at **Fig. 1** from time to time during this discussion will aid you in constructing this antenna in your mind as you read. Perhaps later you can construct it in your garage or shack.

Construction

The telescoped view of **Fig. 1** shows the antenna pulled apart to show how it is assembled. The bottom piece of one inch aluminum tubing may be any length you desire, just cut the top off squarely and clean the rough edges to allow the ⅞ inch inner sleeve to fit inside it. This piece can be about three or four inches long, and is probably the most important part of the antenna. This is where the shield of the coaxial cable is connected. The detailed view of the coax connection shows that one end of this inner sleeve is cut and flattened to provide a way of connecting the coax shield. Since it is difficult to solder to aluminum, the coax braid is removed from the inner conductor by the con-

ventional method of bending the cable, with the plastic outer shield removed, into an inverted U-shape, separating the wire braid of the shield and pulling the inner conductor out through the hole. This is more difficult with the larger cable, such as RG-8, but it can be, and is best done this way. Of course, the smaller RG-58 can be used as well, to lower costs. The shield is now flattened, tinned with solder, and can be fastened to the inner sleeve with a self-tapping metal screw. All holes were made with an ice pick to simplify construction. The coax shield may be permanently mounted after the next step which is construction of the driven element. All elements can be made about 19½ inches long for 144 MHz operation. Allow a little more length for the driven element to go down inside the inner sleeve. The driven element is made from ¼ inch diameter copper tubing to allow for soldering it to the coax inner conductor. The only problem that some of you may find is locating something to hold the driven element in place. In my case this was solved quite easily by a thick-walled piece of rubber hose that tightly fit onto both pieces to provide mounting and insulation. If you can't find a piece of hose try wrapping the driven element with plastic electrical tape to provide the same effect as the hose. After you have done this the coax may now be connected. After the inner conductor is soldered on, slide on the inner sleeve and attach the coax shield. If this makes too large a lump to fit into the bottom piece of aluminum tubing, file or grind it until it does.

Now that this part has been assembled, the ground planes can be attached. These elements were cut from an old TV antenna and are 19½ inches long. Flatten the ends with a hammer and make holes in them for

the metal screws. Make three holes for the screws in the one inch tubing, all the way through to the insulator. Obviously, the screws can not be so long that they will short out the driven element. In this case ⅜ inch long screws worked well. All three elements are tightly screwed into the antenna body to provide a secure mechanical and electrical connection.

The final step is to carefully bend the ground planes up to an angle of 45 degrees. The antenna can be mounted to the bottom piece of aluminum tubing by any way you wish, but in my case, I made a vertical cut in the bottom of the tubing to split the bottom, allowing it to telescope over the top of a TV mast. A clamp was then applied around the split part to tighten the two pieces of tubing together. The coaxial cable then comes down inside the mast. The TV mast was then clamped to the top of my main antenna mast with U-bolts.

Results

The only proper way to adjust an antenna is with the aid of an SWR bridge to determine how well the antenna is matched to the feed line. This also provides a way to check our results. In this case I was very pleasantly surprised to find that the SWR for this antenna is about 1.1:1, a very good reading, considering that no adjustment was made to the antenna before putting it up. The important point to make here is that anyone can construct this antenna without elaborate measurements or adjustments and be confident that it will work, if no drastic errors are made. The SWR stayed very constant over the whole two meter band, showing that it can be used over a wide range of frequencies without degradation of its performance.

Since the top of the antenna is sealed, very little moisture can get in to corrode the coax connection. The coaxial construction, while being physically attractive is also electrically desirable. This antenna has been in use for over a month now and shows no wear in some of the strongest winds that we have here. In the same storm, it even survived the heaviest snow fall that the South Bay Area has seen in eighteen years.

Conclusion

If you have been considering two meter operation perhaps these ideas will provide the incentive that you've needed. This antenna has provided me with an effective "temporary" installation that may last for several years.

. . . WB6BIH

(1) If a ground plane is mounted at the side of a mast rather than at the top, it will give a small amount of gain for covering an area other than a symmetrical circle around the antenna. Be sure to read "The Two-Meter Groundplane as a Gain Antenna", by K6MVH in the January, 1968 issue of *73*.

Improving Frequency Stability in Older Receivers

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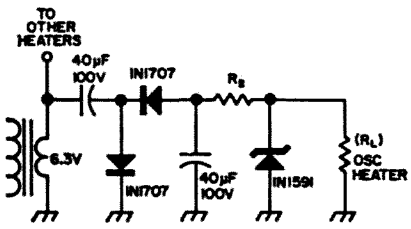


Fig. 1. Modification Schematic

Today's modern receivers and transceivers are marvels of engineering advancement and a joy to look at and operate. Frequency stability and selectivity are just about as good as anyone could ask for. But what about the old clunkers of, say, 1950 and earlier vintage that many of us are stuck with? Components deteriorate with time, temperature, and humidity to the point where many of these older sets are virtually useless for communications purposes, especially on single sideband and cw.

The following article offers an easy and inexpensive way of reducing local oscillator frequency drift to a degree that is competitive with contemporary designs. The writer's receiver is a case in point. Local oscillator drift became so bad over the years that the 25-year-old receiver was impossible in DX or contest work.

The *if* circuits had been reworked in the past for increased selectivity, and the local oscillator drift problem was aggravated because the narrower bandwidth reduced the size of the "window" in which the oscillator frequency had to stay put. Receiver drift became so bad during periods when the transmitter was on the air that it was futile to even call a station in QRM. He just wasn't there when the receiver was reactivated. After losing several DX contacts because of this nuisance, it was decided that something had to be done.

The receiver local oscillator is typical of those in most older sets: a triode in a grounded cathode Hartley circuit, with negative temperature coefficient coupling and padding capacitors. Oscillator plate and mixer screen voltages are stablized with a VR tube. This particular receiver even had a temperature compensating device on the frame of the local oscillator tuning capacitor. This little gadget was a bi-metal strip that operated on the thermostat principle. As the internal temperature of the receiver rises, the bi-metal strip, which is positioned close to the end of the oscillator tuning capacitor rotor shaft, moves in a direction to reduce the oscillator tuning capacity. This, theoretically, is supposed to compensate for the frequency drift.

All the usual remedies to cure drift were tried without much success. Replacing the oscillator, mixer, and VR tubes did not help. The temperature compensating capacitors (coupling and padding) were replaced with units having a higher negative temperature coefficient. This helped to stabilize the long-period drift, but did not solve the problem for short-term variations such as occurred during standby (receiver B voltage off; transmitter on).

A hot soldering iron placed near the bi-metal compensator strip had absolutely no effect. The thing wouldn't budge, even with the iron almost touching it. The only answer to this seemed to be that, over the years, the coefficient of expansion differential of the two metals had somehow changed, so that it was probably near unity; hence no movement with temperature variation. Out with the "bi-metal compensating strip"!

In a final attempt to stabilize the receiver local oscillator, some quick measurements revealed that the oscillator heater voltage decreased from a nominal 6.3 volts to anywhere from 5.6 to 5.8 volts when the trans-

mitter was turned on, depending on what other transient loads were on the 115-volt ac line. One remedy would have been to run a pair of No. 6 ac feeders into the shack, but this would have cost about $100 including materials, electrician's license, and inspection fees.

The circuit of Fig. 1 solved the problem nicely, with a total outlay of about $2.00 for the 1N1591 zener diode. (The other parts were obtained from the junk box.)

The 1N1707 silicon diodes are in a half-wave voltage doubling circuit. The current through resistor R_s depends on the load, R_L; i.e., the current required by the oscillator heater. The only precautions to observe are that the diode polarities are as shown and to make certain that the value of R_s is such that the zener does not exceed its maximum power dissipation if R_L is removed. An added refinement is to include the mixer heater in the regulator circuit, again observing the requirement for maintaining the zener power dissipation within ratings by appropriate choice of R_s.

What actually happens in the oscillator, when heater voltage varies, is that the thermal differential changes the heater-cathode capacitance. The cathode is part of the Hartley tuned circuit, so obviously the LC ratio is no longer constant under these conditions. Another effect is that oscillator grid current also varies, further complicating the stability problem.

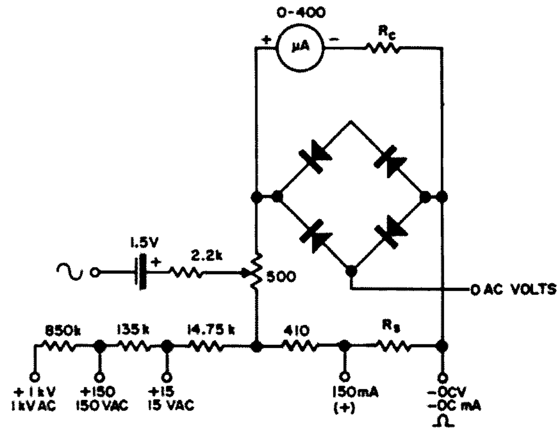
With the receiver cooled down in this manner, the oscillator drift was reduced by an order or magnitude; i.e., from 2000 to 200 parts per million. An added benefit was that dc is used on the heaters, with a corresponding reduction in hum on the 10 and 15 meter bands.

. . . W6NIF

Swedish CB

A note from SM5ZS tells us that there are now about 15,000 Private Radio licenses in Sweden. This is the same as our CB with licenses being issued for $4 to anyone over 18 years old. They may not contact stations which are not on the same license. They are permitted ½ watt on the lower PR band and 5 watts on the higher band. Many potential amateurs are getting interested in radio through the PR license.

VOM SENSITIZER



Here's a way to use a 150 mA VOM as a 0-450 micrammeter—an increase in sensitivity of 333-fold. It takes no transistors, batteries, diodes, or, for that matter, wire or solder. The whole job can be done in five seconds.

The meter used is Radio Shack's small 1,000 ohms per volt VOM #22-4027, which sells for $5.95. Other radio supply houses sell identical or similar ones, possibly made by the same Japanese manufacturer. It's the one that measures 3¼" x 2⅞" x 1".

To make the 0-450 microammeter out of it, simply put the positive test lead in the "AC Volts" socket, and the negative lead in the usual one (labeled DC-ohms in Radio Shack's version), and you're in business.

To see how it works, take a look at the circuit.

The meter movement has a sensitivity of about 400 microamps; R_c, inside the meter, calibrates it to that figure. Used to measure current, the VOM shunts the test leads with R_s, about 2.7 ohms. Remaining current flows through the meter, with 910 ohms in series with the meter's internal resistance of about 100 ohms. Result: 150 mA sensitivity.

But if you feed the unkown current in by way of the "AC Volts" socket (positive) and the "DC mA" socket (negative), the current will flow through part of the diode bridge direct to the meter. This leaves a shunt of 2.7 ohms or so (R_s), but of nearly 913 ohms. This is of course large compared with the meter's internal resistance.

This shunt and the small forward resistance of the diode in series, give a range of 0-450 microamps.

It's a convenient figure, for the calibration on the meter face is 0-150. Simply multiply by 3 to get a true reading. . . .WN6ZRB

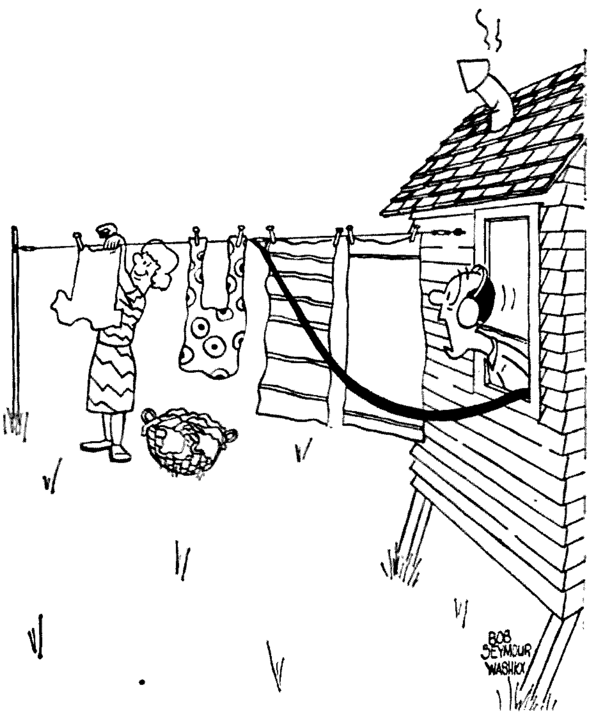
Missed Opportunities

While a lot of hams seem to be looking around for some way to get a toe in the ham business end of things, I notice that one nice little enterprise has been left rather open for several years.

Kits. A few years ago we had a chap down in Texas that used to put together kits for most of the interesting construction projects that were published in the ham magazines . . . particularly those using printed circuit boards. He did a nice brisk business in these kits. Then along came a heart attack and he had to take it easy.

There probably isn't enough profit in the thing to attract a regular parts supplier, one who would have to pay salaries . . . but it should be a good home business for a fellow with some time on his hands and enough money or credit to work up a deal with a parts supplier.

After my own experience in the kit business a couple years ago I would suggest some agreement with the parts supplier whereby he will take back unused parts for credit. The margin on kits has to be rather small in order to attract buyers so you can't really afford to have a lot of stuff sitting around when a kit runs out of steam. I found that kits sold quite well . . . some sold hundreds upon hundreds. My only problem was that I ran out of spare time to do the work needed. This might make a nice little family business.



The Care and Feeding of a Ham Club

Carole Allen W5NQQ
308 *Karen Drive*
Lafayette, La. 70501

Part IV Hams VS the Public

Hams get a lot of publicity, but it isn't always the right kind. One bad case of ham-type television interference can stir up a whole neighborhood, and it takes a lot of good publicity to calm it down. In fact, the more time, money, and energy the publicity chairman has to devote to his job, the better it is for every member of the club.

Sending notices of meetings and social events to members is among the routine duties of the chairman, but there are lots more. Folks who don't know much about amateur radio get the idea that all hams can do is call "CQ", talk about the weather. and broadcast on television sets when the best programs are on. Sooner or later, some of these people ask "why" and want answers.

The "ounce of prevention is worth a pound of cure" policy is always best because folks who realize they may need a high-pass filter on their own TV set will try to sweep their own doorstep before lynching the neighborhood ham. It's safe to assume that the general public doesn't know what knowledge a ham has to have to get a license, the regulations he observes, etc., so this is a good place to start. Every newspaper and radio station clamors for interesting features about local personalities, and the publicity chairman should take advantage of this chance to get the "ham story" across. By introducing an operator and his family to the community and then sneaking in vital facts about filters, FCC regulations, and the ham's role in emergencies anl disasters, the publicity chairman can sugar-coat the public's pill and get alot of information to them.

An informal interview on the local broadcast station reaches hundreds of owners of small filter-less radios who pick up amateur transmissions as handily as some television sets.

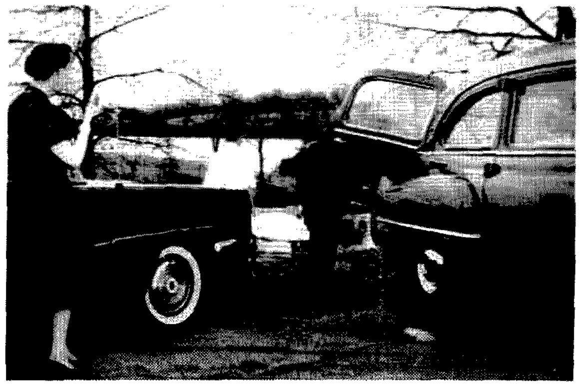
The interview or article should begin with a brief explanation of "How to be a Ham" moving on to the "fun side" about what its like talking to every type, age, size, and color human being all over the world, and then finishing on a public service theme. It's just human nature to enjoy hearing what someone else can do for you, so mention Civil Defense programs, RACES plans, the availability of emergency communications, and the nation's network of willing volunteer hams. If a person is going to know anything about amateur radio, he ought to get all sides of the story.

A sharp Publicity Chairman will always be on the look-out to publicize the activities and public services of local hams. Photographs of each member available for publication add interest to a publicity release.

The publicity chairman should try to strike while the iron is hot when big news breaks. If your club flies into action during a crippling ice storm, hurricane, or forest fire to order medical supplies, provide communications, dispatch trains, or call fire fighters, let the public know. Before the ashes cool or the ice melts, type up news releases for all newspapers in the area. Do the same before and after practice alerts and mobile drills; let the people hear that hams spend hours and days at the job of being ready to work for the public.

Field Day offers another golden opportunity to advance the cause of amateur radio. News releases with photographs of local hams get more attention than a nameless review of what the club is going to do and where. Emphasize and re-emphasize the fact that the purpose of Field Day is to test equipment and train operators who will be needed to serve if real trouble comes along.

The truth is, of course, that bad publicity travels as fast as lightning to ground and people learn all too quickly about TVI, BCI, and HI-FI-I. A Publicity Chairman has to work hard to show John Q. Public that hams are important and valuable members of every community.



In order for a club to be ready to function smoothly during a disaster or emergency, drills have to be planned on a regular basis. Here, a mobile operator (left) relays traffic from the scene of a near-drowning.

How About a Job?

Election of new club officers is sure to start members buzzing, and whether you vote in the spring, fall, or in between, make the most of it. Attendance should be great on election night, for when everyone gets the word that its time to switch jobs around, they'll show up in self-defense to make sure nobody else "volunteers" their services.

One tried-and-true election procedure begins with a list of candidates drawn up by a nominating committee appointed by the president. This group of thinking people can take their time picking prospects who seem qualified for certain jobs. They've got to remember that everybody isn't able to lead a meeting, take down notes, or keep the bank account balanced. Sam's voice may flow like honey when he's holding a mike, but he might spew and sputter with a president's gavel in his hand. In addition to selecting candidates who will work out well, the committee can check to make sure the by-laws of the club are observed. For instance, the Stuyvesant High School Radio Club of New York with 150 members stipulates that their president must hold at least a Technician or General Class license while Novices can be secretary or treasurer if they have spare time after copying code.

To avoid embarrassment and confusion at the election itself, the committee should check with the candidates to make sure they'll accept if voted in. If the "O.K." is given, the list can be presented to the membership for their revisions and approval. The president will ask for nominations from the floor before the final vote in order to give everyone an equal chance.

It's generally agreed that the "secret ballot" is the best way to elect officers to avoid hard feelings among friends. Why risk a rhubarb if it isn't necessary?

Here and there, a club chooses to pass the buck and elect a Board of Directors who function annually to pick a new president, vice-president, secretary, and treasurer.

Sometimes members say "no" to the nominating committee because they're not sure what's expected of them. For this reason, a clear-cut definition of the duties of the officers will be a big help. The Johns Hopkins ARC of Baltimore, Maryland, submitted a good example of a Constitution which leaves no questions unanswered. Consisting of 10 Articles with numerous points of explanation, it covers everything from Purpose and Policies to Voting and Attendance. Under Duties of Officers, the following comments are listed which can be applied to all clubs:

1. The President shall preside at all meetings and shall assume all duties usually associated with this Office. He shall, further, be a member ex-officio, of all standing committees and shall execute

all duties as are assigned him in several places in this Constitution and its By-Laws.

2. The Vice-President shall assume the duties of President in the absence of that Officer. He shall, further, assist the President in all functions of that Office and shall be a member ex-officio of all committees.
3. The Secretary shall keep an accurate record of all Official meetings of the Club which may be ready upon request. He shall also carry out all such correspondence as is necessary in the normal operation of the Club.
4. The Treasurer shall handle the finances of the Club. He shall, further, be responsible for filing the necessary forms with the Student Activities Commission of the Johns Hopkins University for the purpose of obtaining funds from the Club's Account with the Commission. These forms shall be counter-signed by the President.

If the Nominating Committee can cajole, convince, and wheedle members to take over the top spots, their job is almost done; that is, if the club has a constitution similar to the Hopkins ARC specifying that the President shall make various appointments. Among the important chairmanships to be filled are: Publicity, Program, Field Day, Refreshments, Newspaper, Special Projects, Training, Civil Defense and Alerts, Attendance, Fixed Station and Traffic Handling, and dozens of others.

Should the nominating committee or the new president find that nobody's willing to take a job, there's only one course of action left . . . Just fall back on the system used by the Bedford Radio Club of Massachusetts—they call it "lassooing" and it means just what it says.

Do It With Dues!

The best things in life may be free, all right, but it still takes money to run a radio club. Whether your group is big or little, it's easy to list a lot of items that cost; some small, but all essential.

For example, postage for publicity releases, meeting notices, and bulletins requires a substantial amount. If the club mails certificates to those who work a certain number of members, this takes more postage and printing expense, too. Most clubs have bulletins and that means buying paper, stencils, Ditto-masters, and still more stamps. A large group may have to rent a hall, maintain a special building, and pay utility bills. Log books and QSL cards are needed for the club chairman, and don't forget the program chairman who needs a few shekels to rent a film and cross a speaker's palm with silver.

Although there are several ways to keep a treasury in good shape, collecting dues is probably the most dependable one. And almost everyone is used to paying dues in other organizations, so announcing that they're payable won't be a rude shock to anyone.

Many radio club members pay their dues either annually or monthly, and the amounts vary from \$2 to \$5 per year from 25¢ to 50¢ per month. Of course, the method of payment directly affects the amount of club income, so the Monthly vs. Annually payment plan is discussed enthusiastically at a lot of meetings.

The Lump-Sum people contend that forking over the entire amount at one time has several advantages including getting rid of the obligation for a whole year and also in knowing that a member's support of the club continues even if he can't make it to every meeting. Should \$5 dues seem steep for a family of two, three, or more hams, a scale can be used requiring full dues from the "boss" and \$1 for his XYL and each licensed harmonic.

The Pay-as-You-Go folks argue that it's easier on the pocket-book to pay by the month or the meeting. High school and college students who have to pinch pennies appreciate the installment plan more than adults. For this reason, too, a student-rate is used by many clubs to encourage younger members to join. And although a busy ham attends only three or four meetings during a year contributing one or two dollars in dues, he may have a 100 per cent record the following year and more than pay his way.

It would be misleading to leave the impression that everyone pays dues without a second thought, for it isn't the case at all. Most hams meet their obligations as faithfully as they renew their licenses, but now and then someone forgets to pay off. And occasionally a floater shows up who comes to meetings, uses the club station, dirties the ashtrays, and drinks free coffee without adding a cent to the till. This guy can be a problem if too many faithful dues-payers hear

about him. Since the treasurer is the one with the purse strings, he or she knows who pays and who doesn't. Perhaps he can remind everyone at once during the business meeting with a statement like "Say, gang, the treasury's down a little; how about you late ones kicking in your dues?" If this doesn't get results, a notice in the club bulletin along the same lines will serve to remind the delinquent member.

Many folks prefer a regular billing procedure, and if this can be set up, payments are apt to be made on a more business-like level. Of course, in the event these efforts aren't successful, you can try passing the hat to him at the meeting, and if you still don't get a donation, just be thankful he didn't take any out!

. . . W5NQQ

To all ARRL Members

B. R. Council, KØATZ, is a candidate in the upcoming election for Rocky Mountain Division ARRL Director.

"Slats" Council is well acquainted with the legislative and administrative side of Amateur Radio and the ARRL.

Council pledges his strongest action for a better and more representative ARRL, and will do all possible to secure Board action to strengthen ARRL and Amateur Radio in the following:

(a) More DIRECTOR action to secure compliance by ARRL HQ with Board directives.

(b) ARRL support, by QST articles, of FM, and FM repeaters. ARRL to publish an FM manual.

(c) Stronger ARRL action *against* the malicious QRM, obscenity and other illegal operation so prevalent on the bands.

(d) Sale of ARRL publications at lower cost to MEMBERS than to non-members.

(e) An ARRL-operated outgoing DX QSL bureau, without delay.

(f) QST-published factual test results of manufactured equipment.

(g) ARRL support of the EIA Standards project and program.

(h) ARRL Communication Department to better serve the ARRL Members thru handling of routine Comm. Dept. matters.

(i) ARRL to establish DX committee consisting of representatives of leading DX clubs, representatives of all magazines in USA carrying DX matters, plus an ARRL staffer—this committee to arrange for DX contests, awards, and to settle country lists and other similar disputes.

(j) ARRL to take a more active part in the Amateur Radio SPACE program by supporting OSCAR-type projects, and NASTAR, the project to put a ham station on the Moon. ARRL to equip and maintain an ARRL Earth-Moon- Earth station on a 24-hour basis for EME work with other stations.

(k) ARRL to add Field Representatives to better SERVE the ARRL members and the Amateur body as a whole.

(l) Mr. Council pledges to keep the membership fully informed as to the results of legislative and administrative measures brought up to the Board for action, and to take cognizance of members ideas, desires and suggestions, with "feed-back to the members" thru the Director's letter to the Members. ARRL Members will shortly receive literature setting forth the above, in detail. Your careful study and consideration of this material will be worthwhile.

Your vote for Council, KØATZ will help bring about a BETTER ARRL and a more representative type of Directorship in this Division.

Committee to Elect Council and Banks.
A. David Middleton, W7ZC/W5CA, Chairman
Past Director—West Gulf Division
Director—WCARS
Member—Utah Ham Boosters

Using Candles

One of the many cheap but useful accessories in the workshop is an ordinary wax candle. Besides being handy to have around when the lights go out after you "Blow The Fuse", a candle is also:

a . . . the recommended lubricant to use when drilling or sawing aluminum.

b . . . an effective emergency soldering flux.

c . . . good for easing sticking drawers, doors, etc.

. . . R. B. Kuehn WØHKF

Glenn R. Brown W8JZI
689 Drummond Court
Columbus, Ohio 43214

Practical 6 Meter Ground Plane Construction

Many fine articles have been written about the ground plane antenna. These articles go into great detail about polarization, angles of radiation, methods of matching, etc., etc.

This article is intended to show how to *construct* a ground plane antenna for six meters. The method of construction can be duplicated with very little expense, and a minimum of tools. You don't have to be part owner in a machine shop, foundry, or plumbing supply house to get through this project.

Popularity of the ground plane antenna is due to several characteristics. Since the ground plane receives (and radiates) equally in all directions, the ground plane is ideal for local nets. With the increasing availability of good surplus FM equipment, the ground plane should become even more popular.

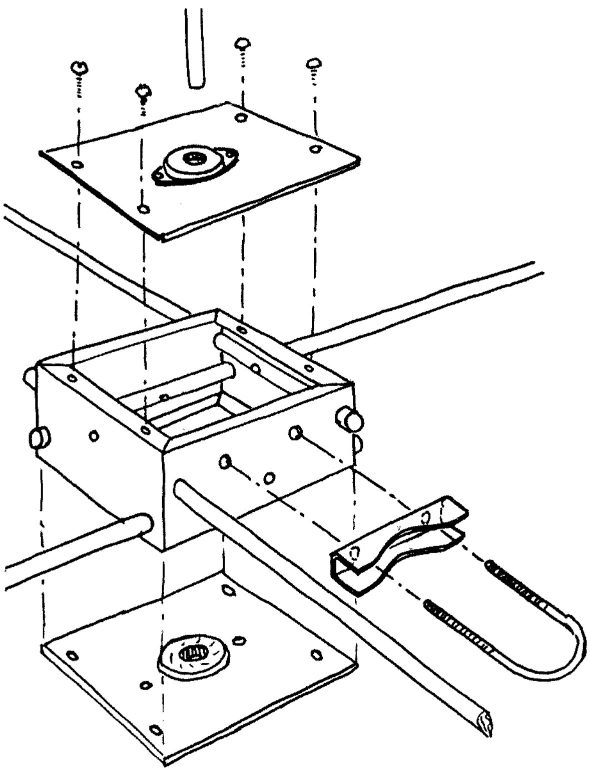


Fig. 1. Construction details.

Since the ground plane is vertically polarized, good reliable communications can be maintained between mobile and fixed stations.

Even the most serious 6 meter amateur should supplement the beam antenna with a ground plane to assure all-around good coverage under all conditions.

Construction. The elements used here were ⅜" diameter solid aluminum tapered shafts, cut down from a Citizens Band Antenna. (This commercial ground plane antenna had failed at the center where elements were joined!) Similar Citizens Band ground plane antennas abound in all parts of the country, and it should not be too difficult to find a damaged or used antenna available at reasonable cost.

The elements can, of course, be aluminum tubing. TV antennas should not be overlooked as a possible source of suitable elements.

Referring to **Fig. 1**, the heart of this ground plane is a *steel* box. The box used here was a *Bud* CU-883-HG Metal Utility Cabinet. (About $1.30 Net). This box comes with 2 removable covers, and necessary screws to attach the covers.

The elements are cut to the proper length for the frequency desired as described in the various Handbooks.

Holes are drilled in the 2" sides of the box for the four horizontal elements. Note, in **Fig. 1**, that two elements are set high, and two are set low, so that adjacent elements will not interfere with each other when inserted into the box.

Measure and drill all holes carefully so that all elements will parallel the top of the box when assembled. Select a drill size that

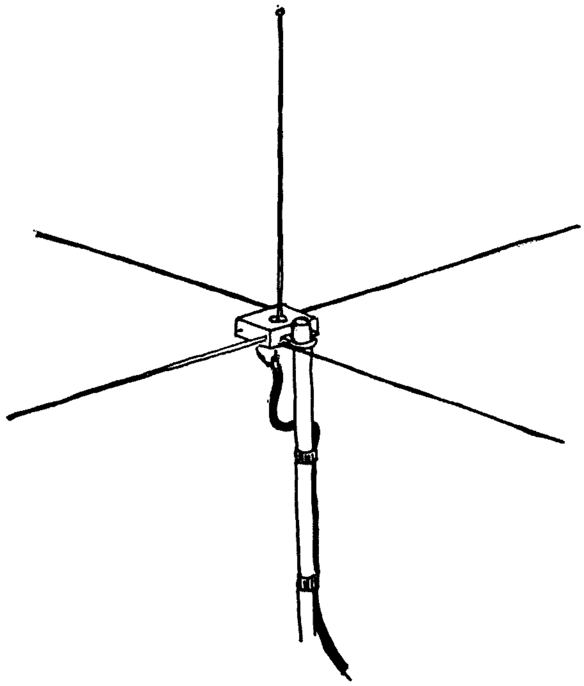


Fig. 2. The completed ground plane.

will give a snug fit when elements are inserted.

Once the horizontal elements are in place, they are secured by drilling a small hole through the box and through the element. A small bolt is then fastened through each element to a nut and lock washer.

The vertical element is insulated from the box by two octal sockets, located in the center of the top and bottom box covers. All pins in the *bakelite* sockets are carefully removed. The center hole in each socket can be filed out slightly to provide a snug fit for the vertical element. A small hole is drilled in the vertical element just above and below the point at which the element protrudes from the assembled box. Small screws are inserted into these holes. The bottom hole provides a point for connecting the inner conductor of the coax feed line.

The ground connection (outer shield) is connected to a lug secured to one screw of the bottom octal socket base.

After all parts have been assembled and checked, the top cover and vertical element are temporarily removed. Holes are then located and drilled for the U-bolt clamp. A convenient length of mast is then placed through the U-bolt and the U-bolt is secured.

The antenna can be re-assembled and the coax attached as shown in **Fig. 2.**

Many schemes of weather-proofing this assembly are available. One unusual and very easy method is to apply undercoating material from an aerosol can. This material is available at very reasonable cost in spray cans from most auto supply houses.

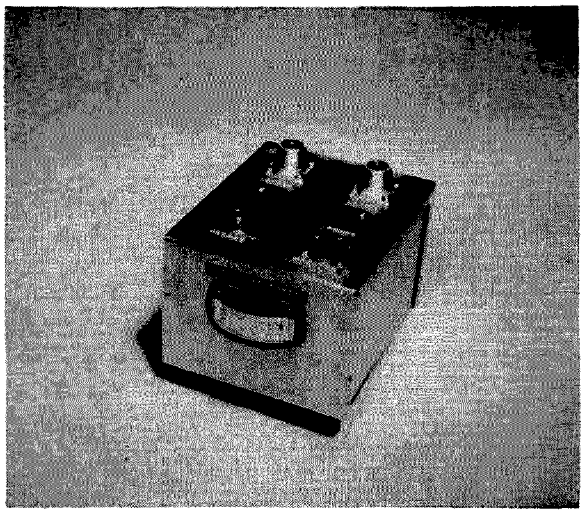
The resulting antenna should provide communications with a minimum of up-keep for several years to come.

. . . W8JZI

CLUB SECRETARIES NOTE

Club members would do well to get their club secretaries to drop a line to 73 and ask for the special club subscription scheme that we have evolved. This plan not only saves each club member money, it also brings badly needed loot into the club treasury, if desired. Write: Club Finagle, 73 Magazine, Peter Boro Ugh, New Ham Shire 03458.

Darn-Handy VHF Monitor



Ralph W. Campbell W4KAE
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Lexington, Ky. 40505

Introduction

The need for a good quality AM monitor for VHF became apparent to myself when delving into high power 2 meter linear adjustments. Using a TX-62 to drive two PL-177WA's in Class B AM linear required a device which could be installed in the output line of the linear so that bias and screen voltages could be properly set. Minimum distortion of the modulated driver was the goal. And, like any transmitter monitor at close range: "'You can't believe that what you hear is an accurate sample,' my friends said" of the actual signal at a distance! Well, this is not always true. Careful experimentation yielded an improved circuit which is presented here. Incidently, most oscilloscopes are ineffective for use on VHF, unless you go directly to the vertical plates: and who wants to botch-up a commercial unit?

Equipment Description & Schematic

The completed VHF monitor is enclosed in a 3 x 4 x 5 inch Bud Minibox. At the rear are the two SO-239 IN/OUT chassis connectors. Either one can be used for input or output to coaxial line. Next, to the left, is an audio jack of the kind that mates with PL-55 type mike plug; but in this case, is used for listening with HI-Z headphones. To the right is an SPDT slide switch: giving the reader a choice of "Power," or "Monitor" switch positions. With a flat line, relative power measurements can be made; and if you follow the instructions given later on: an "engineered-guess" can be made as to the actual power present.

The EMICO'^{tm} meter is mounted by a rectangular retaining speednut in the front wall. To the upper right is the 2.7 µH RFC and the 1N4149 diodes are wired in near this. Observe that the 560 ohm/2 w. resistors are wired to the SO-231 jumper with both resistors in series—first—and then over to the rf coupling capacitor (1pF). They must be connected this way, otherwise enough energy could be coupled in to destroy the diodes.

Fig. 1 is the schematic. The half-wave doubler/detector is straight-forward. It is interesting to note that the coupling value of 1pF works best on the "monitor" position of the unit (listening) for 2 meters, with 100 pF as the output to the audio filter. The same ratio of 1 to 100 holds for the "linearizing resistor" as compared to the output dc load of 220k. The 2.7 µH RFC are chosen to have an impedance maximum just above 2 meters (149MHz) & 39pF discoidal capacitors are series-resonant near the two meter band with usual lead-length. The 0.001 bypass is a ceramic disk, chosen for a low value of reactance as compared

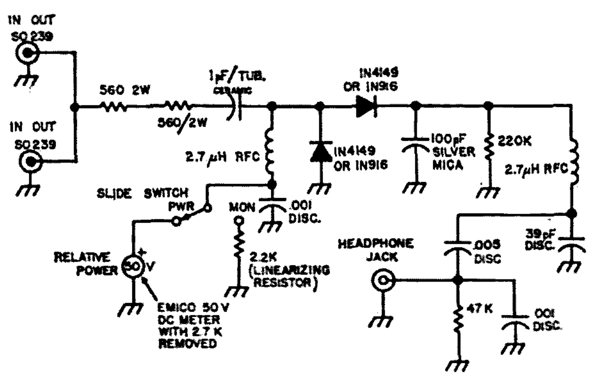


Fig. 1. Schematic for the Monitor.

to the internal meter resistance. The remaining components comprise the audio filtering and coupling.

Using The VHF Monitor

Any power level up to a kilowatt dc input, on two meters, will drive the voltmeter to some position on the scale. 432 would be an upper nominal frequency limit with this unit; however, the "relative power" meter would have little meaning, but it would be useful for tuning-up. If you wish to modify the design for 432, use Z-460 chokes and 13 pF discoidal ceramics. The other capacitors should be left as is. Of course, even with a flat-line you can expect considerably higher meter readings on this band.

On 2 meters, an Ameco TX-62 will give a reading on the meter of about 7.5 volts; for an AB_1 *rf* linear we registerd 15 volts. For the big half-kilowatt Class B linear, we observed 30 volts! A nominal 15 volt reading is equivalent to 75 watts into the monitor in the "power" position; but remember, you must have a flat-line or this doesn't mean anything. And these indications were made from notes in our set-up using a Bird™ Model 34 Directional Wattmeter, in series with the VHF monitor.

Just above we said that "any transmitter" could be used. Don't expect a TWO'er to do more than jar the meter; You will get enough audio through the detector to listen to the signal, though. The main use for the 'Darn-Handy' is to set up 75 watt transmitters & the big amplifiers we use at W4KAE. When adjusting a stage, plug in the headphones, after peaking the output: and listen for maximum *background audio pickup*. Bias and screen voltage controls are to be varied for this purpose. Make sure the slide switch is in proper position. Background pickup is like an increase in gain; without changing the audio level! Preset audio before this step; and you will find bias adjustments related to detected audio. Once you hear the increase in gain, NOW advance the audio gain until the signal is raspy or tinny. Set the audio gain back about ¼ and you're linear. If you can't get enough power output . . . with linearity . . . try increasing the amplifier screen voltage, and repeat the process. . . . W4KAE

Wells Chapin W2DUD
118 Woodmoney Lane
Fayetteville, N. Y.

Simplified Decibel Leveling

Late some night you're listening to the quiet ones. Then you tune into a real whopper and wake up the family. An awful feeling, isn't it? Other awful feelings come up when you over-modulate and get poor reports, or one of those friendly QSL's from the FCC. A lesser annoyance which we could do without, is the variations in roundtable signal strength as nearer or more distant stations come in. Can we do something about these irksome unpleasantries?

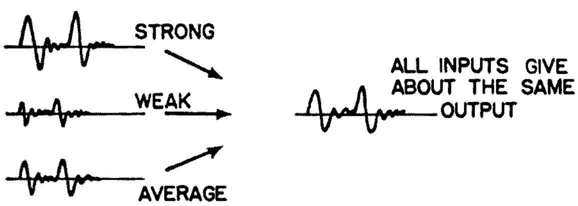


Fig. 1. AVC system adjusts system gain for a roughly fixed output voltage, independent of changes of input amplitude.

Automatic volume control key ideas

What is it we really want to do? See **Fig. 1.** We want a variety of signal strengths to come out all practically the same size. Typically, the circuits that perform this magic do not respond to average levels. They respond to peaks, and hold the peak signal strength to a certain level. The rest of the signal follows along.

But how about very weak signals? Our leveling circuitry reduces circuit gain to pare down the big signals, but when does it start? The simpler control circuits start with the very smallest signal that comes through the circuitry. We avoid this sensitivity loss by adding an extra circuit, which refuses to generate any controlling action until the signal amplitude exceeds a specific, often adjustable value. This is "delayed" control, but with a voltage delay rather than some time-dependent effect. See **Fig. 2.**

This problem of loudness control has received much engineering attention. Searching through the maze of technical literature we find a lengthy list of automatic level control methods, along with a confusing set of names.

An AGC system controls the gain of amplifier circuit, following some predetermined schedule according to changes in the input signal amplitude. If we have an avc system it maintains a constant *output* by adjusting the gain as required, and this is a very different thing. Most "agc" systems might better be called avc systems. Finally, we come across the alc system, which holds transmitted carrier amplitude or sideband power to a constant average value.

For effective use of a volume or level control system, we need to know something about normal speech characteristics. Amplitudes vary widely, from the shouting man's output of five or six milliwatts through the normal conversational range of about 40 microwatts to those soft dulcet tones of perhaps 10 microwatts.

Also, we must know something about speech frequencies. Those frequencies carrying maximum energy are between 300 and 600 Hz, and if we wipe out all frequencies outside the range of 250 to 2500 Hz or so we lose nothing of intelligibility. And, in

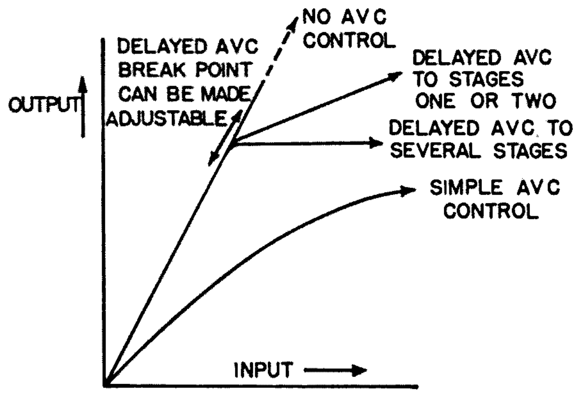


Fig. 2. There are several kinds of avc systems. The delayed avc system is preferable, since it does not reduce small-signal sensitivity of the system. Applying the avc control signal to several stages improves the control action.

transmitter applications this frequency paring saves valuable spectrum space.

Receiver control circuits

Receiving level control circuits feed back a gain controlling signal to the *rf* and *if* stages before the detector. The manufacturer chooses the circuits to use, and their application, and it often appears he could have done a more complete job of it. But he likes to sell simpler designs to stay within price boundaries. Receiving level control systems can often be improved upon, for better general action or to optimize the receiver's performance for a particular type of reception. The requirements for best reception of CW or sideband are quite different from those for AM.

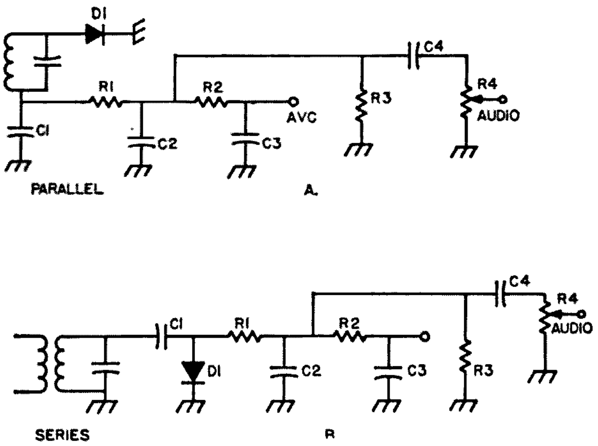


Fig. 3. Series and parallel avc connections. There is no electrical difference between these circuits, but one or the other may be used for mechanical design convenience.

We find it a bit of history in **Fig. 3B**, first used in the late 1920's. It proved to be as good as Armstrong's superheterodyne, and still does a good job today. You may find to your surprise that you are using two circuits invented by Armstrong in WWI in your bright and shiny new receiver. Here, we automatically vary the total receiver gain according to received carrier strength. In this circuit we usually employ variable mu tubes, with the fed back dc control signal adjusting their effective gain.

Fig. 3A shows another version of the same circuit, offering a little leeway in physical construction. Both versions operate in the same way, which we see by looking at CI.

Rectified *rf* produces a varying dc voltage across CI. Going through R1 and R2, past CI and C2, we come to the avc control voltage terminal, which carries practically pure dc after the passage of the rectifier signal through the two low-pass rc filters. And taking the other route we come to the bleeder capacitor R3, which completes the dc path for D1, to blocking capacitor C4, and finally a gain control for adjusting the audio output.

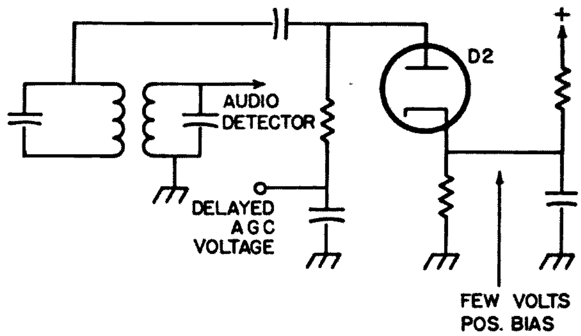


Fig. 4. A reverse-biased diode, separate from the audio detector system, does not rectify any input signal until the signal amplitude exceeds the positive bias applied to D2's cathode. AVC control appears only for large signals.

This arrangement develops a gain-reducing control voltage as soon as there is any signal at all, and if it is preceded by a high-gain *if* circuit it may generate AVC on noise alone. We can avoid this conflict of interests by adding another diode to take off the avc voltage, as in **Fig. 4.** Since diode D2 is reverse biased, it develops no avc voltage until the signal strength exceeds the previously adjusted bias voltage. This is "delayed" avc.

In all receiver avc circuits, the near-dc control voltage is fed back to several earlier stages in the receiver. Generally, the more stages it controls, the better, although there may be little or no control voltage applied to the *if* stage feeding the detector because the signal there is a large percentage of the bias voltages. The usual avc control techniques work best on stages handling a *small* signal voltage, up to maybe 10% maximum of the applied bias voltage. See **Fig. 5.**

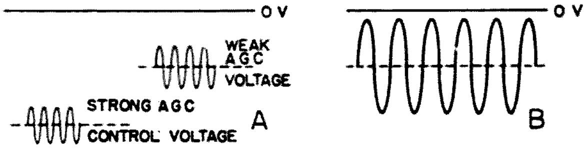
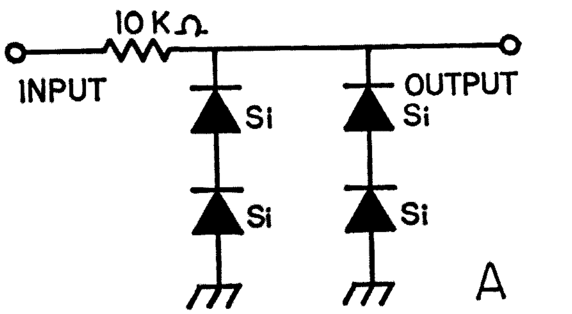


Fig. 5. AVC control voltage usually is not applied to large-signal if or audio stages because the output would be distorted under small-signal conditions. The signal is only small at the input end of the amplifier.



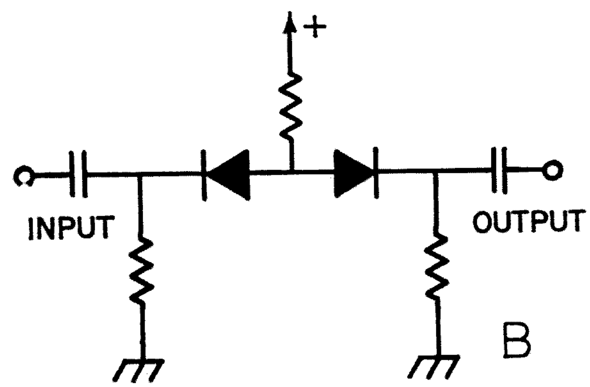


Fig. 6. Parallel and series type limiters. The parallel limiter uses the semiconductor diode property of requiring a rather large input voltage before it conducts at all. The series limiter is permanently biased, with one diode going out of conduction is signal current exceeds bias current.

AVC system design for transistors differs in one significant respect from that for vacuum tubes. A zero-biased vacuum tube is very much alive, but a zero-biased transistor is dead since its base-emitter diode is not energized. So all transistor avc circuits must be provided with sources of base current to energize the transistors when there is no signal, and the increasing signal opposes the fixed bias to reduce base current and transistor circuit gain. In both tube and transistor cases excellent bypassing is required, since the avc lead is common to serveral high-gain stages.

One familiar circuit seems to act like an avc circuit, but it does not have the filter networks and the feedback application of a true avc circuit. This is the simple limiter, which merely clips off any signal amplitude above a certain value. It is a sort of an electrical low bridge. See **Fig. 6A** and **B.**

The shunt limiter is a slightly reverse-biased diode, and when the signal level exceeds a certain value, the diode goes into conduction. It appears as a heavy load across the circuit until the signal returns to more familiar levels. And a complementary circuit, the series limiter, becomes a large series resistance when presented with too-large signals.

Transmitter control circuits

When we begin to think about getting the most effective use from a transmitter, we come to the remarkable variation in loudness of various speech tones. Most of us speak at varying amplitudes and ranges from the mike, closer at one time and perhaps quite distant if we reach for something while talking. It turns out we can achieve a substantial improvement in effectiveness if we apply some or all three of the following electrical treatments to the incoming speech. They are, limiting the frequency range, clipping off large peaks, and applying an avc type system to bring up the low-power parts of speech.

There is no simpler way to limit our transmitted speech frequency range than to choose a microphone that responds only to the important range from 250 to 2500 Hz. But the best limited-response microphones are as expensive as good hi-fi mikes. For example, one 200-4000 Hz communications mike (the Shure 488T) is priced at $34. Another approach is indicated.

Comparable results can be obtained from less expensive mikes, using simple audio filters to attenuate signals outside the important frequency ranges, as in **Fig. 7.** There are lots of these in the handbooks, falling into two general varieties. RC filters, and filters that contain inductive as well as capacitive components. The more complex circuits yield a faster rolloff for a certain number of components, but the rc circuits will do as well if there are a few more sections.

Once we have limited circuit response to

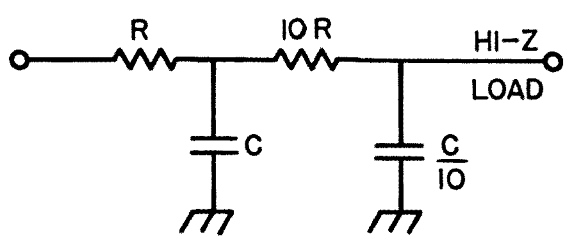


Fig. 7. Simple rc low-pass filter. Second section has same time constant as the first, but larger resistance and smaller capacitance reduced reaction on the first section.

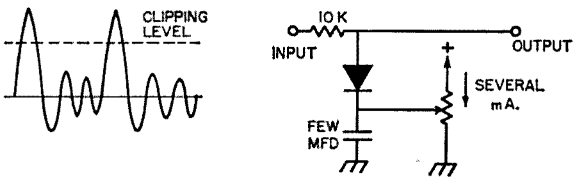


Fig. 8. Speech waveforms are unsymetrical, so a one-sided clipper can pare off peaks. Adjustable bias to control peak amplitude, with audio by-passed through a small electrolytic capacitor.

the most efficient frequencies we are concerned with level control. The simplest level control arrangement is simply to clip off peaks, and not get too close to the mike. See **Fig. 8.** This can be very effective if we use it properly, and follow the clipping circuits with a bandpass filter to remove the high frequencies associated with sharp corners generated by the clipping circuit.

Inside the transmitter we use methods closely resembling the receiver automatic volume control methods described in the last section. The goals are the same, and so are the methods.

The major difference is that we typically take the control voltage from a high power level part of the transmitter, and use a sharp delay action. A small voltage divider as in **Fig. 9** can steal a bit of *rf*, which is rectified by the back-biased rectifier for delay, and fed back to a small-signal audio or low-frequency *rf* stage.

This system is simply another version of the volume compressors used in AM transmitters, except that the return control voltage is derived from the sideband output, rather than from a high-level audio stage.

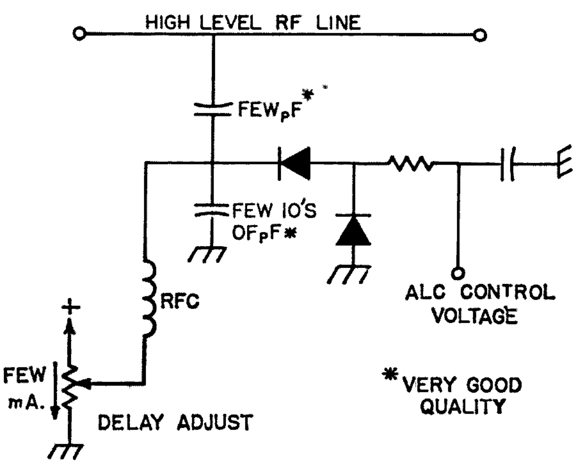


Fig. 9. Stealing a bit of rf voltage for automatic level control. Good bypassing required to avoid unwanted rf feed-back to earlier stages of transmitter.

Breadboarding AVC circuits

AVC circuits are easy to breadboard, and they can be tested using normal audio or *rf* generators. The *rf* has to be controlled carefully so that it does not find unwanted routes past the attenuator into the circuit, giving false results. Alternatively, a breadboarded avc circuit can be tested in two steps.

After breaking the avc feedback line, the circuit response is observed for various signal strengths, measuring the avc voltage. And then, with a fixed input signal, the circuit gain is checked against variations in avc voltage, which can be fed into the broken avc line from a simple battery and pot arrangement. . . . W2DUD

FM'ing a VFO

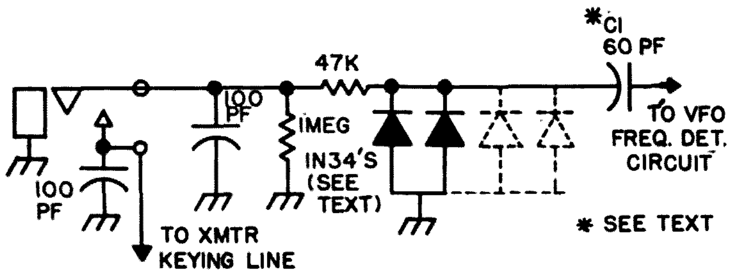


Fig. 1. See text.

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3160 Fairmede Drive
Richmond, California 94806

With the interest in 2 meter FM Repeaters these days, and with many of the hams being active on 2 meter AM, there have been many conversions for FM'ing 2 meter rigs.

Recently I acquired an Ameco VFO-621 to add to my 2 meter AM rig. Being a member of two FM Repeater groups, I immediately started researching to find a suitable way to FM the vfo. All of the circuits I found were too complex. By this, I mean they involved a lot of time and expense. Being lazy and wanting to use my junk box, the circuit in **Fig. 1** evolved. This circuit is not new—Gonset uses a similar circuit in their VFO. The difference comes in that they use a Varicap (voltage variable capacitor) costing about $4.00, and not in the average ham's junkbox! The same effect can be had with any germanium diode—it just takes more of them.

I wanted to achieve plus or minus 15 kHz deviation and the values shown will give that much deviation with the Ameco VFO-621.

This circuit can be adapted to any VFO, either commercially made or home-brew by changing the value of C1 and varying the number of diodes.

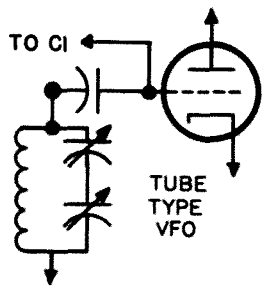


Fig. 2.

A good place to start is with 2 diodes and about 5 pF for CI. If that does not give enough deviation, increase CI to about 10-20 pF and add another diode. By varying CI and the number of diodes you can come up with any amount of deviation you want.

The input to the circuit should be a high impedance ceramic, crystal, or dynamic mike. I use a Collins MM-1 dynamic but a cheap crystal or ceramic high output mike will work fine.

The capacitors across the mike input and the keying line are to keep *rf* off the leads to prevent the VFO signal from leaking out except when the spot switch on the rig is turned on. In the VFO-621, the oscillator runs all the time and the buffer stage is keyed.

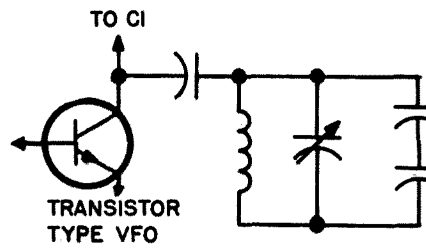


Fig. 3.

In my VFO, CI goes directly to the collector of Q1, the oscillator. In the other VFO, the circuit should go in parallel, that is, across, the frequency determining circuit. In a tube type VFO, usually the grid of the tube will be in place. See **Fig. 2.**

If your VFO quits with the addition of this circuit, try a smaller capacitor at CI. Make CI as big as you need to get the deviation you want and if the VFO oscillator quits before you get CI large enough, use more diodes to make CI just small enough so the VFO still takes off OK.

I mounted a mike jack right on the VFO chassis near the oscillator. When on FM, I plug the mike into the VFO; for AM the mike goes into the normal mike jack on the 2 meter rig.

After installing the circuit and finding the proper combination of C1 and the number of diodes to get the deviation you want, you must recalibrate the VFO using standard procedures.

The comments from listeners on the air has been that the quality is excellent and has a "hi-fi" sound.

. . . WA6UFW

FCC Announcement

This is to advise that the previous announcement concerning the exchange of third party communications with amateur stations in West Berlin has been rescinded. It has been determined that the regulations of the Federal Republic in Germany, which in effect prohibit third party communications, also apply to amateur stations in West Berlin including stations operated by United States Forces personnel.

FET Preamplifiers

John J. Schultz, W2EEY/1
40 Rossie Street
Mystic, Conn. 06355

Two extremely simple, but effective as well as inexpensive, FET rf amplifier circuits are presented which can be used to boost the performance of an existing receiver or transceiver.

Field effect transistors are semiconductor devices that have properties similar to a triode vacuum tube—high input impedance and large dynamic range. These properties make them especially suitable for use as *rf* amplifiers or preamplifiers. The FET in this application has also one extra advantage over a triode in that the feedback capacitance is lower than the grid-plate capacitance in a triode used as a *rf* amplifier and so operation on higher frequencies without neutralization is possible.

The two *rf* amplifiers described in this article are built around a newly developed plastic-packaged economy FET from Motorola—the MPF 157. Although other FETs can be used, the MPF157 is highly recommended since it is available for less than $1 and is specifically designed for *rf* amplifier use. The MPF157 will operate at frequencies up to 400 megacycles/second, although neutralization will be required. The low feedback capacitance of less than 0.2 pF eliminates the need for neutralization for most 80-10 meter circuits. The unit will provide at least 16 db gain and the noise figure should be 4-5 db.

The *rf* amplifier circuits shown may be used in whatever manner the reader wishes—as a mast-mounted preamplifier for a single band to improve a receiving system, as a bandswitched preamplifier at the receiver, or even as the *rf* amplifier stage in a receiver.

Single state amplifier

Fig. 1 shows the schematic of the simple single stage amplifier. It will operate properly with a drain supply of 12 to 15 volts (20 volts absolute maximum), thus making it useful in mobile situations also. The coil

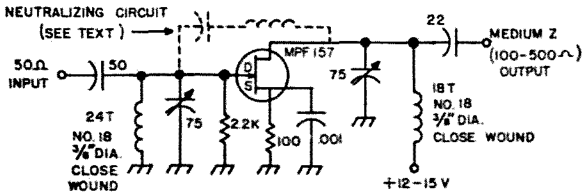


Fig. 1. Single stage FET preamplifier. Coil dimensions are for 20 meters. For untuned or broadband operation, input and output circuits are peaked at opposite ends of the band.

dimensions shown are for operation on 20 meters but with the aid of of a grid-dipper, coils can be developed to cover any desired band. If the circuit is used on frequencies higher than about 30 MHz, a neutralizing circuit between the drain and gate terminals of the FET will be necessary. The series capacitor is usually made fairly large (.001 μF on 6 or 2 meters) and the coil made broadly self-resonant. Although the dimensions of the neutralizing coil are almost impossible to specify exactly because of the dependence upon individual circuit layout, a good starting point is to make it with about 6 times as many turns as the coil in the drain output circuit. If avc or manual gain control of the stage is desired, the grounded end of the 2.2 K ohm gate resistor is lifted and connected to a negative control voltage.

Cascode amplifier

Fig. 2 shows the schematic of a two-stage FET amplifier. It uses direct coupling and is a modification of the so-called Wallman configuration. The vacuum tube equivalent is the direct-coupled driven grounded grid circuit and the FET circuit has most of the same characteristics. The amplifier is quite

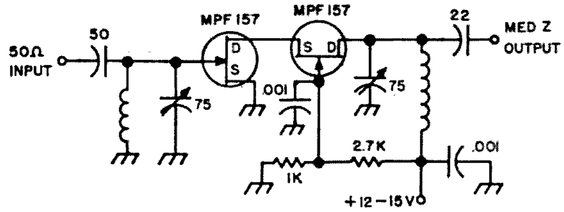


Fig. 2. Cascode amplifier circuit. Input and output circuit values are the same as Fig. 1 for 20 meters.

stable because of the low drain load on the first stage. Neutralization is often not required although at VHF frequencies the noise figure of the overall amplifier may be improved by neutralization. The voltage gain of the first FET is negligible and the main gain is provided by the second FET. On the other hand, the noise figure of the overall amplifier is determined almost entirely by that of the first FET. Thus, if it is possible in any way to evaluate the noise figure of individual FETs, the best one should be used as the input stage. Another approach is to use sockets for the FETs rather than hard-wire them and switch the FETs to determine which way they perform best.

Construction and Adjustment

The construction used somewhat depends upon the application for which the amplifier is intended. For instance, for use as a single-band preamplifier, the variable capacitors shown in the diagrams can be replaced by fixed values once the proper values have been determined with variable capacitors. Final peaking can be done by pinching the coils. The coils themselves can be wound on any convenient form—1 watt 1 megohm resistors, for instance. The photograph shows the cascode circuit assembled on a piece of vectorboard using fixed value capacitors (silver mica types should be used except for bypassing where disc types can be used). No particular circuit layout is required except that the input and output coils should be as far apart as possible and oriented at right angles to each other. On VHF a shield, in addition, may be required between the coils. The entire assembly should be enclosed in a shielded container when used as a separate preamplifier outside of a piece of equipment.

One note of caution is necessary when handling the FETs. They come with their leads shorted together because static charges may damage them because of their extremely high input impedance. Handle them by their case and leave the leads shorted until the FET is placed or soldered in a circuit.

Summary

The MPF157 allows the construction of a relatively inexpensive but high performance amplifier. It's low current requirement (5 to 6 mA) for either circuit allows it to be operated from a battery source for extended periods of time or allows power to be furnished for operation from the internal power source in any receiver or transceiver.

. . . W2EEY/1

A Report on the WTW

I have been asked by quite a few fellows where should they send their cards to be checked for the WTW. This time I will make a complete list of all check points we now have. If your area is not covered you should send your cards to me at:

Gus M. Browning, W4BPD,
Route 1, Box 161-A,
Cordova, S.C.

along with the $1.00 to cover costs of the certificates, handling, etc. PLUS enough EXTRA to pay for the return of your cards —otherwise I will return them to you via THE CHEAPEST WAY I CAN—and don't blame me if they go astray! We are still looking for check points—so if you are a member of a well established club or society—how about discussing the handling of our cards by them, provided they are in some area which doesn't now have a check point.

The following stations have qualified for these WTW awards since last issue:

WB2RLK-WTW-100, 14 MHz phone
W2VBJ-WTW-100, 21 MHz phone
K5HYB-WTW-100, 21 MHz phone

Still QRX for anyone who qualifies: Certificate Nr. 1-WTW-100, 28 MHz CW. Certificate Nr. 1-WFTW-100, 7 MHz phone, and both CW and phone Nr. 1 for 80 meters. Some good low numbers are still available in most other certificates. And I am glad to report I am now checking ALL CARDS SENT ME within 7 days, and I am sure all check points are doing the same— I suggest sending cards via Certified mail, it's much cheaper than Registered and I think just as safe. Of course with a return receipt requested for proof of delivery.

I would like to call to everyones attention that a PHONE QSO is a phone QSO as far as we are concerned—It can be either SSB, AM, NFBM or any other way you can have a VOICE CONTACT. We only go by whats shown on the cards you submit to us. If you can get a CW station to listen for your phone signals and his card says ur SSB or AM or NBFM is Q-3, S-2 with no mention of CW on the card—thats OK as far as I am concerned. The same goes with CW. We have no way of knowing if it was TWO-way phone or not, we can only go by whats on the card you send us. We don't encourage this practise of course—sometimes this is doing it the hard way.

Beginning with this issue we will list STANDINGS in our Honor Roll. Send us your CLAIMED SCORE—BUT when you hit the next WTW level WE WANT TO SEE THE CARDS. Would like to have your score as soon as possible so the standings will be of more interest to everyone.

WTW HONOR ROLL (claimed scores)

#1—W4NJF —261—14 MHz phone
#2—XE2YP —209—14 MHz phone
#3—WB2WOU—204—14 MHz phone
#4—WB2NYM—204—14 MHz phone
#5—WA5LOB —202—14 MHz phone
Others with much lower scores, will QRX for a late score from them for next month.

#1—W4OPM —220—21 MHz phone
#2—WA8WRP—106—21 MHz phone

#1—W5DAJ —103—28 MHz phone

The complete list of ALL WTW CHECK POINTS:

W1/K1—NONE (send cards to me)

W2/K2—NONE (send cards to me)

W3/3—Western Pennsylvania DX Society,
John F.Wojtkiewicz—W3CJY
1400 Chaplin St.,
Conway, Penna. 15027

W4/K4—The Virginia Century Club,
P.O. Box 5565,
Virginia Beach, Va. 23455

W5/K5—Garland Amateur Radio Club,
2905 Sheridan Drive,
Garland, Texas 75040

W6/K6—Orange County DX Club,
James N. Chavarria
3311 Stearns Drive,
Orange, Calif. 92666

W7/K7—Western Washington DX Club,
William H. Bennitt, W7PHO
18549 Normandy,
Seattle 66, Wash. 98166

W8/K8–Straits Area Amateur Radio Club,
William Moss–WA8AXF,
307 Grove St.
Petoskey, Mich. 49770

W9/K9–The Montgomery County Amateur Radio Club,
Scott Millick–K9PPX
Litchfield, Ill. 62056

WØ/KØ–NONE (send cards to me)
ALL CANADIAN DISTRICTS SEND CARDS TO:
The Edmonton DX Club,
(VE6GX) 12907–136th. Ave.
Edmonton, Alverta, Canada

OCEANIA–ALL EXCEPT HAWAII (Hawaii to W6/K6 check point)
The New Zealand Association of Radio Transmitters (NZART)
Jock White (ZL2GX) Contest & Awards Manager
152 Lytton Road,
Gisborne, New Zealand

ALL SOUTH AMERICA–Venezuela Amateur Radio Club,
P.O. Box 2285–ATTENTION OF: YV5CHO DX Committee
Caracus, Venezuela, South America

ATTENTION ANY CLUBS ON Southern part of South America, we need a check point for this part of South America.
EUROPE: NONE (send cards to me)
AFRICA: NONE (send cards to me)
ASIA: NONE (send cards to me)

AGAIN I REPEAT: We are in need of other clubs for WTW check points. Especially in Asia, Africa and Europe as well as the few we still don't have covered in the USA. How about a club in Mexico too?

Thats it for this month, thanks fellows—LETS HAVE YOUR CLAIMED SCORES, etc.

. . . W4BPO

W2NSD/1 from page 2

phone office and routed from there. If the phone on the other end is busy the office there would hold the recording until the phone was available and then send in the message.

Future Magazines

Several technological developments are closing in on the old fashioned magazine. The one that looks like a comer to me is color television with video tape. If you leave a tape on an individual frame you can read that frame just like a page in a magazine. A magazine the size of 73 would take very little tape. Perhaps we will be able to have a small tape cassette for each magazine.

Subscribing and billing would all be done in an instant. It doesn't look like it will be many years before all our banking will be instantaneous, eliminating the need even for small change. You will probably be doing almost all of your shopping via color television . . . mail order . . . just punch the button on your set when you flip to the ad you like and it will be delivered that same day. Why go to the supermarket when you can flip through their catalog on TV and have whatever you want delivered almost immediately?

It is unfortunate that our television standards were frozen as early in time as they were, back when the picture was relatively crude compared to those possible today if our standards could be changed. Some of the European television has considerably better definition than ours because they standardized a few years later. Perhaps when we make the change to satellite broadcasting direct to homes we can use a new set of standards.

The magazine via television could come in a few pages every day rather than waiting for one big lump a month. I suspect that the costs of "publishing" and distribution may be enough lower so you will be able to have a lot more material and advertising costs will be but a fraction of those today. The costs may go back up if magazines integrate moving sequences with the single frame readout. The Life magazine of the future may be more of a half hour program that you can subscribe to . . pay TV . . . rather than a magazine. Like the old March of Time.

A magazine today has to pay the authors for the articles . . . and pay well and rap-

idly. Then, in our field, we have to have the schematics drafted by professional draftsmen. Type has to be set, engraving plates have to be made of the drawings and the photographs. Everything has to be read carefully for mistakes. The articles are then put together on the pages and made ready for printing. More proofs . . . more proofreading. When everything is all set one copy of each page is printed and an offset negative is made of the page. The negatives are pasted together in 32 page groups and a large printing plate is made of that.

Meanwhile, off in Canada, a swatch of trees has been felled and crushed into paper, coated for a nice looking page, and shipped to the printer. We use up to 40-000 pounds of paper for an issue . . . that is about 20 tons! This whizzes through the press in a couple of days. The pages are then folded, collated, glued together and trimmed. Subscriber copies are wrapped and the address label from our computer in Massachusetts stuck on. Bulk copies for radio parts stores and newsstand distributors are bundled and shipped by truck or mail around the country.

Every one of the hundreds of people involved in this whole operation have to be paid. Plus our bookkeeper, advertising department, and other staff. A lot of money could be saved if we could eliminate the printing.

The day is approaching when type will mostly be set by an advanced type of typewriter. The IBM chaps arrived here the other day with just such a machine hoping to sell it to me. I am not ready to buy a $4000 typewriter yet, even if it does do a fine job of setting type. I suspect the day of the old Linotype machine are numbered now. It can't be long before most printers change to something like this IBM job. Just a few years ago offset printing couldn't compete with letterpress for our type of magazine . . . now we are offset and it is working out quite well. The obvious next step is in typesetting.

Subscription Premiums

The idea of giving prizes for selling subscriptions to a magazine is not new. Older readers certainly will remember the glowing ads for free bicycles and things that used to appear in the comic pages, just for selling subscriptions . . . or Christmas cards . . . or soap.

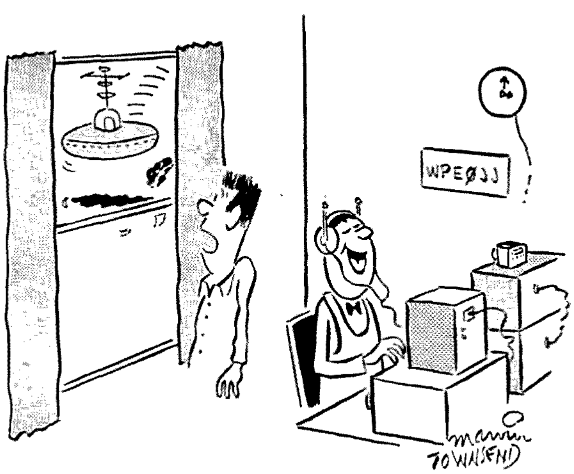
The idea still seems to work. We have quite a number of 73 fans who are working their way through our list of prizes. The slide rule, being one of the easiest to get, is by far the most popular. The parts bins, digital clocks and operating desks have been keeping us hopping too.

We have had a little trouble getting across the concept that these prizes were for *selling* subscriptions to 73 and not for *buying* them. There is a basic difference there. This month we capitulate and allow the addition of a renewal to accompany the new subscriptions. This means we have to offer a little less for each new subscription. After all, the money for the prizes comes from our savings on soliciting *new* subscriptions. We still have to send out renewal notices.

The result of all this has been one of the most rapid periods of growth in the history of 73. We've had to double our staff here to handle things. The early miseries of our computer for subscriptions are past and we are now able to handle a growth like this without falling to pieces.

Advertisers will have to face another rise in our rates. The economics of publishing dictate that the advertising revenue must pay for the printing bill. And as the circulation increases so does that bill. The post office grabs a good percentage of the subscription money and promises to take even more as they decrease service.

Wayne



"This'll give you a laugh! Some wise guy is giving me the call letters UFO."

UFO from page 4

UFO activity for your area you will be the one that is called when something is doing . . . and that is fun. Just the other day I got a call from a farmer in Francistown. Seems that he had been haying down in this field and saw some mighty peculiar burnt spots that he knew had not been there before. He asked around and someone remembered ny name and he called me.

Lin and I drove right up to take a look. Sure enough, we found two circular almost bare spots along the edge of the field. It looked as if something about three feet thick and 21′ in diameter had set down there for a while. None of us could imagine what on earth could have made two identical marks like that about 50 feet apart, plus several smaller bare spots about ten feet in diameter. The farmer swore they hadn't been there before this summer.

Almost identical marks have been found in other fields near here in the past and no one has an explanation. It was interesting to me that just about a half mile up the hill from the bare spots was a microwave repeating tower. Hmmm.

I reported the whole matter to the local NICAP investigator and Dean Coles at Franklin Pierce College. Dean is going to make some radioactivity tests on the spots.

Like I say, when you get involved in this you can have a lot of fun.

UFO NET SCHEDULE

Wednesdays 0200 GMT 14,300
Thursdays 0200 GMT 3950

. . . W2NSD/1

SUBSCRIBERS

We want to make absolutely sure that no one is using our 73 mailing list. We do not rent this list out as do other magazines. If your address label from 73 is distinctive and you find that you are getting any mail addressed in the same distinctive way please let us know immediately and send us the envelope or wrapper that you received so we can take appropriate action. Your help in this will be very much appreciated.

International Notes

The DARC recently reported that there are now 11,997 DJ, DK, and DL licensed amateurs in Germany, 497 DL4-5, and 1491 DM's. The annual membership fee for the DARC is, by the way, $10. 87% of the licensed amateurs in Germany are members of DARC. When you consider that $10 in Germany is about equal to $25 here in terms of comparable prices and wages, it is obvious that the DARC must in some way have won the confidence of the German amateur. Perhaps our ARRL, with about 27% U.S. amateur support, could get some pointers from DARC?

160M buffs may be interested to know that the German bands are 1825-1835 kHz and 1985-1992 kHz.

Interested in a short term DL license? Write to DARC International Affairs Office, Muehlenstrasse 27, D-5601, Doenberg, Germany. Complete regulations for amateur radio in DL can be obtained from Secretary DARC, Beseleralle 10, D-23, Kiel, Germany.

The SRJ (Yugoslavia) now has 400 radio clubs, 30,000 members (including school children), 5000 radio operators and 1800 amateur transmitting stations (1200 private, 600 club). During the 7th National Convention in June there were competitions for the fastest construction of radio equipment by children, a QRQ contest for adults (code speed, if you don't know your Q-signals), an amateur radio cartoon contest, a contest for the best jokes in an amateur's life, an exhibition of home-made gear and foxhunting for children and adults on 3.5 and 144 MHz. Program chairmen for our conventions please take note.

Region III (Asia) of the IARU has had difficulty in getting together for meetings up until this year due to the distances involved. Australia, New Zealand, Japan and the Philippines were able to send representatives for the first meeting this year. The Wireless Institute of Australia will provide the secretariat and the funds will come from member societies.

Visiting Finland? Reciprocal licenses can be had for $11.33. Send for application to SRAL, Box 10306, Helsinki 10, Finland.

Licenses for Italy? Send for application to ARI, via Vittoria Veneto 12, Milan.

Propagation Chart

OCTOBER 1968

ISSUED AUGUST 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7A	7	7	7	7	7	14	21	21A	21A
ARGENTINA	14A	14	14	7A	7	7A	14A	21A	21A	21A	21A	21A
AUSTRALIA	21A	21	14	7A	7A	7B	7B	14B	21	21	28	28
CANAL ZONE	14A	14	7A	7	7	7	14	21A	21A	21A	21A	21
ENGLAND	7	7	7	7	7	14	21	21A	21A	21A	14	7A
HAWAII	21A	14	14	7A	7	7	7	7B	14A	21A	28	28
INDIA	14B	7B	7B	7B	7B	14B	14A	21A	14	14	14	14B
JAPAN	14A	14	7A	7B	7B	7	7A	7B	7B	7B	14	21A
MEXICO	21A	14	7A	7A	7A	7	14	21A	28	28	28	28
PHILIPPINES	14	14	14B	7B	7B	7B	7B	14	14	14	7B	14A
PUERTO RICO	14	7	7	7	7	7	14	21	21	21	21	14A
SOUTH AFRICA	14	14	14	14	7B	14A	21A	28	28	28	21A	21
U. S. S. R.	7	7	7	7	7B	14B	21	21A	21A	14A	14	7A
WEST COAST	21A	14	14	7A	7A	7	7A	14A	21A	21A	28	28

CENTRAL UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21A	14A	14	7	7	7	7	7	14	21	21A	21A
ARGENTINA	21	14A	14	14	7A	7	14	21A	21A	21A	21A	21A
AUSTRALIA	21	21	14	7	7A	7A	7B	14B	21	21	28	28
CANAL ZONE	21A	14	14	14	14	7	14	21A	28	28	28	28
ENGLAND	7A	7B	7	7	7	7B	14	21A	21A	21A	21	14
HAWAII	28	21	14	14	7A	7	7	7B	14A	21A	28	28
INDIA	14	14	14	7B	7B	7B	7B	14	14	14	14	14B
JAPAN	21A	14	14	7B	7B	7	7	7	7B	7B	14	21A
MEXICO	21	14	7A	7	7	7	7	21	21	21	21	21
PHILIPPINES	21A	14A	14	7B	7B	7B	7B	14B	14	14	14	21
PUERTO RICO	21	14	7A	7	7	7	14A	28	28	28	28	21A
SOUTH AFRICA	14	14	14	14	7B	7B	21	21A	28	21A	21A	21
U. S. S. R.	7B	7	7	7	7B	7B	14B	21	21	14	14	7A

WESTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21A	21	14	7	7	7	7	7	14	21	21A	21A
ARGENTINA	21A	14A	14	14	14	7A	7A	21A	21A	21A	21A	21A
AUSTRALIA	28	28	28	14A	14	14	7B	7B	14	14	21	28
CANAL ZONE	28	21	14	14	14	7	7A	21	28	28	28	28
ENGLAND	7A	7B	7	7	7	7B	7B	14	21	21A	21	14
HAWAII	28	28	21	14A	14	14	7A	7	14A	21A	28	28
INDIA	14	21	14	7B	7B	7B	7B	7B	14	14	14	14B
JAPAN	21A	21	14A	7A	7	7	7	7	7	7	14	21A
MEXICO	21A	21	14	7A	7A	7	7	21	28	28	28	28
PHILIPPINES	21A	21A	14A	7A	7	7	7	7	14	14	14	21
PUERTO RICO	21A	14	14	7A	7A	7	7A	14A	21A	21A	28	21A
SOUTH AFRICA	14	14	14	7B	7B	7B	7B	14A	21A	21A	21A	21
U. S. S. R.	7B	7B	7	7	7B	7B	7B	14B	14A	14	14	7A
EAST COAST	21A	14	14	7A	7A	7	7A	14A	21A	21A	28	28

A - next higher frequency may be useful this period
B - difficult circuit this period

Good: 1, 2, 4-6, 9-12, 14, 16-18, 23-25, 27-30

Fair: 3, 8, 13, 15, 21, 22, 26

Poor: 7, 19, 20

Caveat Emptor?

★ Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

FOR SALE—perfect condition Clegg 22er $175.00. Central Electronics 10A with coils, $65.00. Will ship. F. Myers, 1403 Main St., Honesdale, Pa. 18431.

SELL! HRO50T1, ABCDEF coils, speaker, manual, $165.00. Will ship prepaid. Cashier check or postal money order. Clyde Lee, K4OOW, 925 Blue Springs Dr., Pensacola, Fla. 32505.

GROUNDED GRID FILAMENT CHOKES, 30 amps, ferrite core, ¾" x 5", $4.00. Plate chokes 2500 VDC 800Ma, $2.00. PPUSA48. Calif. add tax. William Deane, 831 Sovereign Rd., San Diego, Cal. 92123.

HAM—TV, Close Circuit TV Camera—$125.00, Hitachi 7735A Vidicon—$15.00, Toshiba 7038 Vidicon—$10.00, Reverb—$15.00, Simpson 260-5 VOM—$35.00. Stan Nazimek WB2GKF, 506 Mt. Prospect Ave., Clifton, N.J. 07012.

THE OAK RIDGE RADIO OPERATOR'S CLUB will sponsor the 18th Annual Crossville Picnic at Cumberland Mountain State Park July 20-21. For information write The Oak Ridge Radio Operator's Club, Inc., PO Box 291, Oak Ridge, Tenn. 37830.

ART-28 TELEVISION transmitter. Excellent condition with plugs, manual, and power supply. 400 watts peak power. $125. Warren Dunning, 2828 S. Simpson St., Philadelphia, Pa. 19142.

COLLINS 75-A3, .8 and 3.1KC. Mechanical filters, 100KC calibrator. Product detector and hang A.V.C. added. Realigned, recalibrated, excellent. Price $225.00. W5NHB, 4615 Laurel, Bellaire, Texas 77401.

WANTED. January 1961 issue of 73. Please state condition and price. W2DYY, Russ Schroeder, 469 Salt Rd., Webster, N.Y. 14580.

HILLSBOROUGH AMATEUR Radio Society, Inc. (HARS) Annual Tampa, Florida Hamfest will be held Sunday, October 13, 1968 at Lowry Park (Sligh Ave. and N. Blvd.). Free parking—many prizes.

SWAP 514 AD 410B each Harrison Power Supplies. Goodies for linear 4-1000A 4 spare tubes. Want TR4 or similar size. Write Swift, W1CZM.

SELL: Immaculate SB-34 transceiver with mike, $300. Eico electronic keyer, new, $45. Hallicrafters SX-42 and R42 speaker, aligned and reconditioned, $150 or make offer. KWS-1 serial, #1465, $800. Knight RF 'Z' bridge impedance device, $10. Turner 80X microphone, $5. Eldico SSB-100F aligned and reconditioned, $275. Spare 5894/AX9903, good, $4. Lee Richmond, 166 Floral Ave., Plainview, N.Y. 11803, GE 3-8663.

"SAROC" FOURTH ANNUAL National Fun convention hosted by Southern Nevada ARC, January, 8-12, 1969, Hotel Sahara's new Space Convention Center. $12.00 Advance Registration accepted until January 1, 1969, regular registration at door. Ladies program in Don the Beachcomber. Technical seminars; ATV FM, MARS, RTTY, QCWA, WCARS-7255, WSSBA meetings. Golf and bridge tournaments. "SAROC" registered participants entitled to special room rate $10.00 plus room tax per night single or double occupancy, admittance to cocktail parties, technical seminars, exhibit area, Hotel Sahara's late show, Sunday Safari Hunt breakfast (equal to any banquet—ask any "SAROC" veteran). "SAROC" brochure planned for November mailing QSP QSL card for details. Please send separate checks for accomodations and registration now if you like to W7PBV c/o "SAROC" Hotel Sahara, Las Vegas, Nevada 89109.

MICRO-MICRO-TO KEYER: Perfect code from one cubic inch, microcircuit digital electronic keyer module designed for mounting inside any transmitter. Speed range 4-40 WPM. Grid block keying only allows price of $19.95. Includes mounting hardware. Unconditionally guaranteed. Micro-Tech Labs, PO Box 884 (I.A.B.), Miami, Fla. 33148.

NATIONAL 200, A/C 200; A/C power supply, NCXD-DC power supply. Very good condition, almost new. Extra rig, and must sell to best offer. WA2OHN, 845 Cliffside Ave., North Woodmere, New York 11581.

WANTED: Teletype equipment & parts. Also R-390A/U-R, R-220, etc. Cash or trade for new amateur equipment. Alltronics-Howard Co., Box 19, Boston, Mass 02101 (Tel: 617-742-0058).

STARTING A HAM STATION? Tell us requirements and cash available. Will advise on best possibilities. $3.00. WB6VFG, WB6YPF, 1035 N. Ave. 63, Los Angeles, Calif. 90042.

DO YOU HAVE A PROBLEM with your equipment? Let the communications specialists handle it for you. Complete amateur service—kits wired, tested. J-J Electronics, Canterbury, Ct. 06331.

VARIACS: Panel mount, in new condition—20A—$32.50, 6A—$12.95, 1¼A—$6.25. Condenser, computer grade, 74,000 Mfd. @ 10 V DC—$1.89. Send for catalogue listing other condenser bargains; Nicads; Solid State material; test equipment and other "hot" items. Advance Electronics, 54-M West 45th St., New York, N.Y. 10036.

WANTED: April 1964 and 1965 issues of QST. Write box 691, Savannah, Georgia 31402.

SWAN 250 + 117XC P.S. $300. Confirm, like new, no trades. Bob Hopkins, 5631 West Morris St., Indianapolis, Indiana, Phone: 241-1638.

TR 4, W/P., RV4, FF1 crystal control, NCL 2000, $695 FOB. W6VHS, write or listen 14250±.

RCC Panoramic Indicator 455kc IF, 115V 60cy ....EX 67.50
Reflectometer SWR Bridge w/Meter, 30-1000mc. ...EX 8.50
BC733F 108-110mc Converts to Satellite Recvr. ....EX 8.75
Weston Meter Module 843 Type 5. 500-0-500ua ....EX 4.75
T23/ARC5 100-156mc w/Tubes ....GOOD 14.50
R26/ARC5 3-6mc Receiver w/Tubes & Dynamotor..EX 9.75
T20/ARC5 4-5.3mc used 5.00—**T21/ARC5** 5-7mc ..EX 6.00
AT141/ARC12 225-350mc Broadband Stub Antenna..EX 3.00
AM40A/AIC Interfone Amplifier w/Dynamotor ....EX 4.75
T465/ALT7 200W Xmlttr 168-352mc w/2 6161's ..EX 19.50
T465 Schematic pp. 1.00.....Complete Manual pp. 6.50
TCS12 Xmittr/Recvr Control Box with Speaker ....EX 6.75
Jones No. 574.23 Micromatch Doubler Coupler ....EX 12.50
C18 A.R.C. Type 12 Equipment Control Box ....NEW 1.50
C1457 Control Box for R550/ARR40 Receiver ......LN 1.75
C760B/A Control Box for ARN14B&C Receivers ....LN 4.50
C45 Control Box for ARC1, 4 & 12 Equipment ....EX 1.35
6161 Tube w/Connectors. 100 Watts to 1200mc. ....EX 6.75
R101A/ARN6 100-1750kc Receiver. Four Bands ..EX 27.50
ID91B/ARN6 4" Navigators Bearing Indicator ....EX 7.50
AS313B/ARN6 Station Seeking Loop. 100-1750kc. ..EX 6.25
ID169C/APN12 3JP1 CRT Scope. Coax Switch ..NEW 12.50
PP336 Main Power Supply for APR9 Receiver ....EX 16.50
PP337/APR9 Klystron Supply for TN130, TN131 ..EX 10.50
ID226 Panoramic Indicator for APR9 Receiver ....EX 14.50
Scope Xformer 1950V@3ma 5 Fil Windings 60cy. ..UN 4.75
SA325/U Coaxial Switch SP4T 38VDC Motor ......EX 6.50
Adaptor Cable PL259 to BNC Panel Socket .....LN 3/1.75
Fib'rglass Insulating Rod ¼" Dia by 7½" Long ..EX 5/1.00
OHMITE Z-50 Radio Frequency Choke ....EX 6/1.00
Rt. Angle Drive w/Gears, Universal, ¼" Shafts..EX 2/2.50
Feed-thru Capacitors 15 on Panel....Three Panels ... /1.00
BNC (UG290/U Coaxial Panel Sockets ....EX 8/1.00
Coax 6" long w/BNC (UG260A/U) Plug each end EX 5/1.00
Coax 8" w/1 BNC Plug & 1 BNC Panel Socket ..EX 4/1.00

E. C. HAYDEN Box 294, Boy Saint Leuis, Mississippi 39520.
Prices: FOB Bay Saint Louis. **Terms: Net, Cash.**

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We have to move a quantity of material out of one of our storage areas, and need room.
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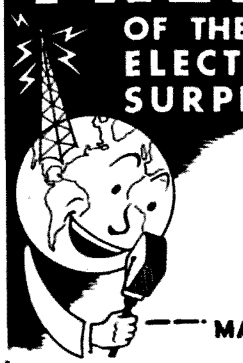

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HEATHKIT: HR-20 REC., HX-20 XMTR (SSB, VOX, VFO), HP-20 AC power supply. All operating. $200. M. Kaplan, 23038 Lanark St., Canoga Park, Calif. 91304.

HIPOWER PP4E27 linear amplifier. Surplus item suitable foundation unit for grounded grid per August 73 article. Equipped, variable tank inductor, no junk. $15.00. Megeff W2DXK, 5015 Weeks Lane, Flushing, New York 11365.

SIDEBAND PACKAGE. Swan 240, Heath HP10, AC supply, Hallicrafters PS150-12 DC supply. $200. Bruce Tepper K6HET, 12402 Killion Street, North Hollywood, Calif., 91607.

SELL: Heathkit SB-400, $275.00; SB-200 with spare finals $200.00 or make offer. S.A.S.E. Jim WB6MQE. 517 E. Emerson Ave., Monterey Park, Calif. 91754.

FOR SALE: Swan 250 with 117XC AC power supply, used 5 hours. Price firm: $220. FOB Stanhope. Glenn C. Ward, WA2KZF, RFD 1, Stanhope, N.J.

WANTED: Microwave gear, waveguide, couplers, mounts, etc., for amateur group. Send list and prices to S. Daskam, K2OPI, RD 2, Box 360, Flemington, New Jersey 08822.

SELL: Mint SBE-34, SB2-LA, Mike, Mobile mount, Hustler Deck MAST, W/resonators for 75-40-20 meter bands, Mini-Products unused 2-element 6 through 20 meter beam. First certified check for $550.00 or best offer takes it. WA9PTJ, SSGT. Laurence E. Rasmussen, Co. C, Box 82, DLIWC, Monterey, California 93940.

NATIONAL NC-300 receiver, with Knight-kit with Knight-kit crystal calibration. Excellent crystal calibration. Excellent condition, $120 postpaid. WN9VAQ, 526 East Jefferson, Columbia City, Indiana 46725.

SWAN-250, mint. All factory improvements including calibrator. Three hours air time. Price: $275; includes 7-element Finco 6-meter beam. W6NFW, 51 Washington, San Juan Bautista, Calif. 95045.

FIRST CLASS RADIOTELEPHONE correspondence course from Cleveland Institute of Electronics. $50. It really works! Larry Pirkl, Box 5391, NDSU, Fargo, N.D.

NCX-5, DC SUPPLY, parts for AC supply, used mobile only, later serial #.... $395.00. W1FBT, 46 Pearl Street, Quincy, Mass. 02169.

WRL'S USED GEAR has trial-terms-guarantee! $129.95; Comm II, 6-meter—$89.95; SR46—$94.50; HW12—$89.95; HW22—$89.95; SB33—$199.95; Galaxy III—$189.95; Galaxy V—$289.95; Galaxy V Mk 2—$329.95; Galaxy 300—$159.95; AF68—$69.95; HX50—$199.95; RME6900—$149.95. Hundreds more, free "blue-book" list. Write WRL, Box 919, Council Bluffs, Iowa 51501.

TUBES WANTED. A,,types higher prices paid. Write or phone CeCo Communications, 120 West 18th Street, New York 10011. Tel. 212-242-7359.

WANT AEROTRON or similar 2M AM xtal receive & transmit transceiver, AC power, for remote control work. W1KCR, Box 25, Claremont, N.H. 03743.

RTTY GEAR FOR SALE. List issued monthly, 88 or 44 MHy torroids 5 for $1.50 postpaid. Elliott Buchanan & Associates, Inc., 1067 Mandana Blvd., Oakland, California 94610.

DISCOUNT PRICES—TIME PAYMENTS! New Swan equipment, factory sealed cartons, full warranty at discount prices. Swan 500C $468, Swan 350C $378, Swan 250 $292. Immediate delivery. New CDR Ham-M with indicator $99.95, TR-44 $59.95. Hygain antenna specials TH6-DXX $135, TH3-MK3 $108. Tower special Tri-ex W-51 self supporting crank up—shipped prepaid $299.95. All equipment listed is new in factory sealed cartons with full warranty, in stock for immediate delivery. No down payment with approved credit. 36 months to pay. Write or call for "discount price quote" on all brands of amateur equipment. Bryan W5KFT, Edwards Electronics, 1314—19th St., Lubbock, Texas. 806-872-8759.

WANTED: Military, commercial, surplus Airborne, ground, transmitters, receiver, testsets accessories. Especially Collins. We pay freight and cash. Ritco Electronics, Box 156, Annandale, Va. Phone 703-560-5480 collect.

3000 V @ 3μF brand new GE Pyronal oil capacitors $3 each. Can mail, 3-lbs each shipping wt., FOB. P. Wandelt, RD # 1, Unadilla, New York 13849.

Tell Our Advertisers

You Saw It In 73

CAN I GET A PRIZE WITH MY RENEWAL?

Yes . . . if you bring a friend.

Your renewal (or extension of subscription) plus a new subscription for a friend is the key to the prices given below. USA or APO only. And please send us the address from your wrapper. All items are postpaid unless marked FOB.

	your cost
1. Digital clock with date ($50)	$38.00
2. Caslon Digital desk clock ($25)	16.00
3. Rotating three tier parts bin ($5)	free
4. K&E Slide Rule ($5)	free
5. Inside-outside thermometer ($5)	1.00
6. Rand-McNally Imperial Atlas ($13)	4.00
7. Rand-McNally Magellan Globe ($14)	6.00
8. Car blanket with case ($12)	2.00
9. 15 Transistor AM/FM bat.-ac ($35)	19.50
10. AM/FM-Clock ($65)	32.50
11. Lamp-clock-radio ($35)	19.00
12. 13" Hammond world globe ($13)	5.00
13. 13" Hammond lighted globe ($17)	8.00
14. 18" Hammond world globe ($17)	10.00
15. 18" Hamond lighted globe ($25)	13.00
16. Polaroid Big Swinger camera ($25)	17.90
17. Polaroid 215 camera ($56)	43.00
18. 4-drawer desk ($45) (FOB)	24.00
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AMATEUR RADIO 73

November 1968

73¢

Computer Card Transmitter

Crystal Filters

Trouble Shooting Solid State

I.C. Counter

Pulsars

Thermistor

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73 MAGAZINE

November 1968
Vol. XLVII No. 11

STAFF

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Cover: A typical ham workbench in operation. Photo by Fred Meyer

Next Month: Transceiver review, Ham gifts under $20

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73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

I keep getting the word from the Subscription department that there are numerous requests for 73 to print a picture of the Editor. Actually, my picture appeared on the cover of the October 1967 issue. I'm the one working on the antenna. For those who may have missed it, copies are available for 73¢.

This is the second month without a "Letters" column. This is not due to lack of space, but lack of mail. Normally, the only people who write are those who disagree or have complaints. Most of these give constructive criticism and have something worth printing. In the past couple of months, the only letters I have received have been nice ones with compliments about the quality of the magazine. If I printed only the nice letters, you would think I was hiding the bad ones. Tell me what you want....this is the only way I can improve 73.

Under the "Big Deal of the Year" department comes the news that Kentucky, the last state without call letter license plates, has passed the following legislation:

"**188.176 Amateur radio licensees may attach plate showing call letters to license plate.**

"An owner of a motor vehicle who is a resident of this state and who holds an unrevoked and unexpired official amateur radio station license issued by the Federal Communications Commission may attach to his motor vehicle license plate an additional license plate inscribed with the official amateur radio call letters of the licensee, provided the additional plate is attached in such manner as to not interfere with the view of the motor vehicle plate. (1968 H 226. Eff. 6-13-68)"

The amateurs of Kentucky must be *thrilled*!

A couple of states issue two sets of plates and the call letter plates may only be attached if a mobile rig is installed in the vehicle. If you take the rig out, you must change the plates. There may be some merit in this in times of emergency where identification is required to enter a disaster area. Only the cars capable of being useful would be permitted to enter the area. The call letter plates would serve as identification. However, not all the police know about call plates. I was once stopped by a police officer in Glendale, Colorado. I had Colorado plates with my call WØHJL. He came to my car window and, in a sarcastic tone, asked, "OK, lady, where did you get the license plates, out of a cereal box?" Between convulsions of laughter, I explained the situation. After seeing my registration and my ham ticket, he had a very red face.

In a few countries, hams are permitted to hold a call only upon proof that they have an *operating* station. If the station is dismantled, the license must be relinquished. It is held for a reasonable length of time, then becomes eligible for reissue. When the amateur gets another station on the air, he may get his license back without taking a new examination (if still within the expiration time limits) but may be assigned a new call. There may also be some merit in this system. If amateur radio exists, as we are told, only because of our involvement with Public Service, should a ham hold a license if he is not in a position to render such service?

I'd be willing to bet that less than 50% of the hams listed in the *Callbook* are active amateurs with operational stations. In many areas, we have used up the W, K, and WA calls. In two areas, we have used up the WB calls and are into the WC calls. If only the amateurs with operational stations were permitted to hold a license, we could all have W or K calls.

Each year the *Callbook* gets fatter and fatter, and the price goes higher and higher. If the inactive hams were eliminated,the U.S. callbook would be about the size of the DX book, and the price would go down.

November 22 is rapidly approaching. Although I don't usually plug products in the editorial column, a new company has come out with a crystal calibrator divider which makes your 100 kHz crystal put out a tone each 25 kHz. It is a miniature printed circuit board requiring the soldering of four wires and will let you know where you are at all times. It comes from Paxitronix and their ad appears on page 124. This little gadget costs under $6 and is a necessity for the ham who didn't take the higher class exam in time.

. . . Kayla W1EMV

de W2NSD/1

The latest Callbook lists about 6500 Extra Class licensed amateurs. This does not have the look of a mass move to me. A look at the previous two Callbooks confirms my suspicion. The Summer edition showed an increase of 229 Extra Class licenses over the Spring issue and the Fall issue went up by 332 more. Perhaps the November 22nd change in the frequency allocations will make the cheese more binding and we will see a more decided trend toward the higher classes of license.

License Class	Spring '68	Summer '68	Fall '68
Extra	5875	6104	6436
Advanced	39040	39406	39638
General	116005	116822	116513
Conditional	42825	42963	41626
Technician	63693	64870	63505
Novice	12467	11820	13124

There is not any great noticeable rush for the Advanced Class license either, as you can see. 366 in the second quarter and 232 in the third quarter seems to me to indicate either advanced apathy or else a sit-out strike. I expected a little heel dragging about this "incentive program", but not almost total rejection of it.

Perhaps others feel as I do. Ham radio has been my major hobby for thirty years now and by virtue of my having gotten my license many years ago I have the Advanced Class ticket. I get on the air with my little transceiver (with linear) whenever I can, and generally enjoy talking with friends all over the world. The QRM gets to me now and then. Though I've lost all track of how many countries I've worked and my main connection with DXCC is as its critic, I do love to work DX. But . . . somehow I dislike being punished into doing something rather than being rewarded into it. Ask me and I'll do almost anything . . . tell me and I'll resist with all my strength.

Doubtless this resistance to authority is some sort of psychological defect in my makeup. Yet it is so deep that I accept it as a philosophy and I feel that this is a better way to run a country. It is tied in with freedom in my mind and government edict is the antithisis to freedom for me. This seems to me to be the one basic difference between a totalitarian government and a democratic government.

This is why I resisted as much as I could when the ARRL proposed the incentive licensing changes. I felt that we could achieve whatever aims they had . . . and these were *never* stated, by the way . . . by offering rewards rather than punishment. As I pointed out at the time, we have wide areas of our bands that are virtually going to waste which could have been offered to the Extra Class licensees to make that ticket sweeter. There would have been little problem in opening up an extra 50 kHz on the five major bands for Extra phone. This would have given us bands rather than taking them away.

Unfortunately for all of us the ARRL managed to get its way in spite of overwhelming protests and on November 22nd we can tune our re-apportioned bands and see how it works out. The Extra Class segments are going to be pretty thinly occupied, obviously.

Here are the new allocations.

	Extra CW	Extra Phone	Advanced
80M	3500-3525	3800-3825	3825-3850
40M	7000-7025	7200-7225	7200-7225
20M	14.00-14.25	14.2-14.235	14.2-14.235
15M	21.0-21.025	21.25-21.275	21.275-21.3

That gives the Extra Class a 25 kHz exclusive band on the low end of 80-40-20-15 for CW and 25 kHz of exclusive phone frequencies on the low end of the 80 and 15 meter phone bands. The Advanced Class can join the handful of Extras for 25 kHz on 80-40-15, and 35 kHz on 20 meters. The General Class will have to move out of the lower 50 kHz of the 80M and 15M phone bands, the lower 25 kHz of 40 meters and 35 kHz of 20 meters. Sorry about that, but that's what happened to us.

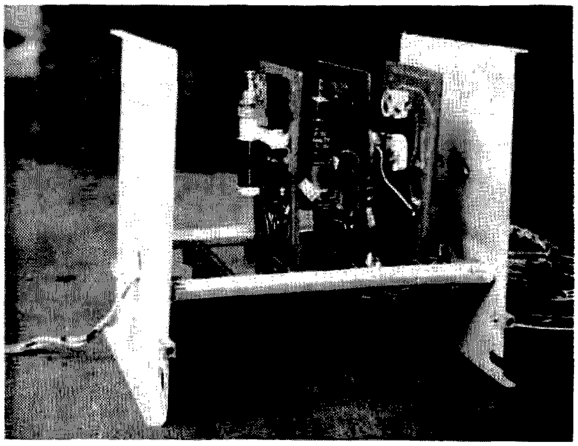
The new regs will probably result in a field day for a band of self appointed righteous "police" who will be eagerly looking up every call heard on these bands in the Callbook to see what class license they have. Then, when they find someone out of his band they will break in with great glee to demand that he get up where he belongs. If you hear anyone doing this please break in yourself and tell him that Wayne Green says

(Turn to page 114—it's really there!)

George R. Allen K1EUJ
74 Wells St.
Westerly, R.I. 02891

Computer Card Transmitter

A Simple Hybrid Rig for 80 Meters



Front view of the Computer Card Transmitter.

This simple rig for 80 meters was designed for the ham who can't leave well enough alone. It consists of three sections, all constructed on surplus plug-in computer cards to facilitate experimentation and modification. Each section may be removed, modified, and worked on at will without touching the other sections, and by using additional plug-in cards, new circuits may be designed and tested while keeping the old cards intact. Thus an operating version of the rig is always available while new changes and designs are being tested.

This rig has also been designed for the ham who has always stayed away from transistors fearing that they are too complicated. The transistor oscillator described in this article is very simple to build, uses three $1 transistors, and will work first time if the instructions in this article are followed. The oscillator itself should present no problems even for the inexperienced ham.

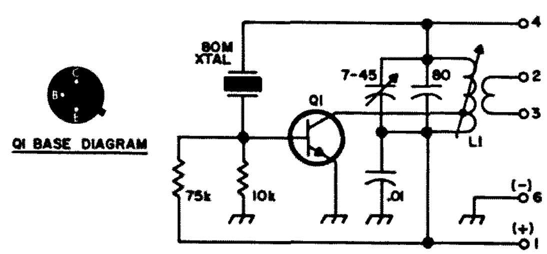
This rig has been designed for 80 meters because out of sheer laziness, I haven't gotten around to winding the coils for the other bands. I will leave the other bands to the builder who may experiment to his heart's content by using other plug in boards.

For information on construction on surplus plug-in computer cards see my article "Computer Card Construction" in 73 magazine earlier this year.

The oscillator

The oscillator is somewhat standard and should give even the inexperienced builder no trouble at all. It oscillates readily and because it uses a slug tuned coil will resonate over a range of plus or minus 75 kHz from some center frequency without retuning. If reduced output from the final can be tolerated, it can be operated over the entire 80 meter band without retuning.

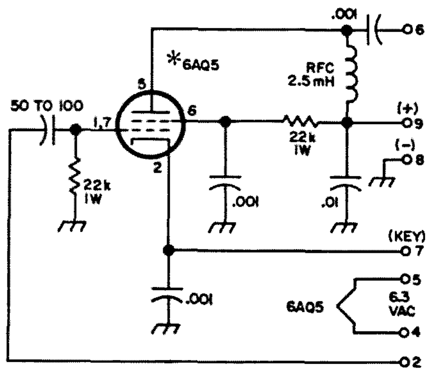
The original circuit had no variable capacitor in the oscillator tank circuit. Originally small capacitors were soldered in place until the circuit resonated at the crystal frequency. I then tolerated reduced output for some frequencies and operated the rig over the whole 80 meter band. However, for ease of adjustment, this circuit was modified as shown in **Fig. 1** to include a small 45 pF trimmer so that the unit could be easily adjusted. The oscillator coil does not have to be wound on a slug tuned coil if broad band operation is not desired.



Q1 = 2W NPN 100 MHz SILICON TRANSISTOR RADIO SHACK PART NO. 276-507 (SIMILAR TO 2N696, 2N697, 2N1613)

L1 = 5ST NO. 26E CLOSEWOUND ON 1/2" DIA SLUG-TUNED FORM (MILLEN 69046). B+ CONN. OPPOSITE MTG END. TAP 1ST FROM B+ CONN. LINK IS 4T NO. 26E CLOSEWOUND AT CENTER

Fig. 1. Oscillator card with broad band operation.



* MOUNTED IN RIGHT ANGLE PRINTED CIRCUIT TYPE TUBE SOCKET (ELCO NO. 05-4006, 05-4007)

Fig. 2. Diagram for the final amplifier card.

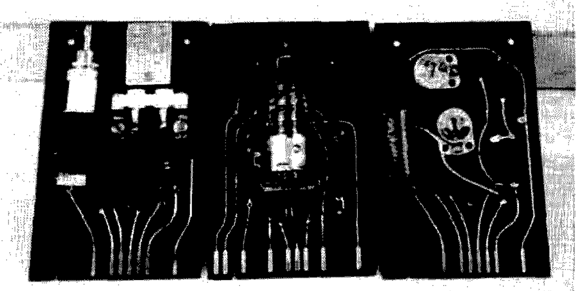
The oscillator will become a bit unstable and may cease oscillation as resonance is approached. For this reason, the oscillator is considered to be properly tuned when maximum drive is obtained, or when the oscillator current is about 40 mA.

It is possible to tune the oscillator by varying the movable slug; however, this method is not recommended since it varies the feedback and causes current fluctuations which are hard to interpret. The slug tuned coil is used only to provide a broadband oscillator circuit.

The tap on the oscillator coil has been adjusted for optimum operation; however, for experimentation purposes, the position of this tap may be varied. The circuit will oscillate quite readily when the collector of the transistor is connected directly to the crystal end of the tank coil; however, at this position, the oscillator will produce very little drive and draw little current. As a matter of fact, if you wish to use this circuit as a spotting oscillator to find certain frequencies, connect the collector to the crystal end and use 6 volts or less for voltage. As the position of the tap is advanced from the crystal end toward the battery end, the oscillator will draw more current and deliver more drive until a point is reached where the circuit becomes unstable and eventually ceases to oscillate. As mentioned before, the circuit as shown will work without difficulty and will produce enough drive to push the final to 14 or 15 watts, thus it should be used at it is.

If you will notice on the circuit in **Fig. 1**, a low impedance link is shown on the oscillator coil. This link is not used at the moment but will be used in the second version of the transmitter which has a transistor final amplifier. This second version is currently being designed.

There are no precautions to worry about when building this unit other than not to get the transistor too hot when soldering it into the circuit. The best idea is to use a small transistor socket and solder it into the circuit. The oscillator, when it draws 40 mA at 18 volts, runs about ¾ watt. To prevent damage to the transistor a small heat sink should be used. I used a small surplus finned heat sink. Similar sinks can be obtained from Allied Radio. The sinks are made by Wakefield-Engineering and are numbers NF205 and NF207.



Front side circuit boards.

The final amplifier

The final amplifier circuit is nothing out of the ordinary, and there is little to say about it. I had originally planned the final to be transistorized too, but I ran out of transistors and decided to use a tube. The tube socket specified on the schematic must be used to permit the tube to be mounted parallel to the computer card. When mounted this way, it sticks out from the card for less than an inch. When fully loaded, the final should draw between 40 and 50 mA at 300 volts giving a power input of a little less than 15 watts.

The tank circuit

The tank circuit was originally designed for single frequency operation as the trimmer capacitors were mounted right on the tank circuit card. This proved to be incon-

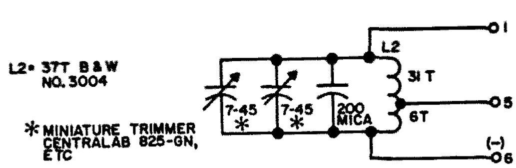


Fig. 3. The tank circuit card diagram.

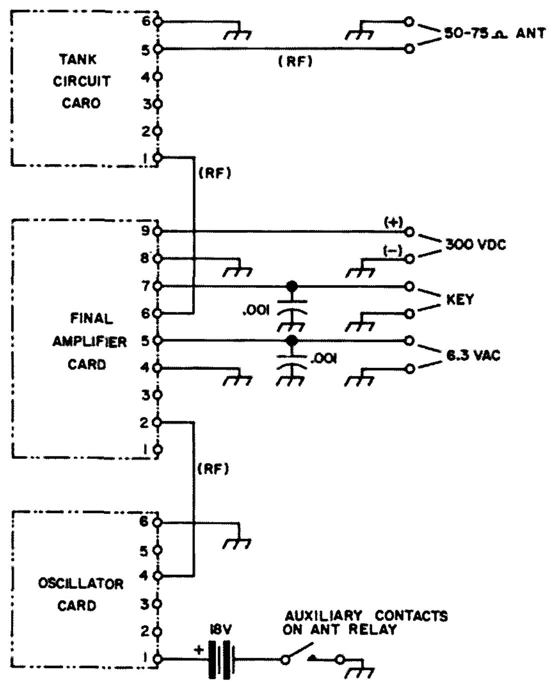


Fig. 4. Card socket wiring diagram.

venient, however, as I use this rig for the entire band. Thus, one trimmer capacitor was eliminated and a 100 pF capacitor which was mounted on the card rack was used instead. By varying both capacitors the tank will cover the entire band.

The output of the rig was designed for 50-75 ohm cable, and seems to work well into a load of this impedance. If you desire, you may change the output circuit to anything which happens to suit you merely by building a new circuit on another plug-in card and then swapping cards.

Tune up and operation

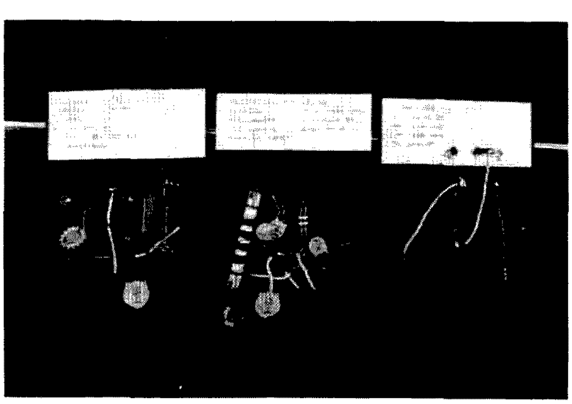
In my particular setup, the transistor voltage is supplied by three 6 volt lantern batteries. You may use any dc supply which delivers between 18 and 24 volts.

For testing purposes, connect a 5 or 10 watt lamp to the output to be used as a dummy antenna. Screw the movable slug on the oscillator coil all the way in and be sure that the heat sink is on the transistor. Connect a key to the key circuit and place a 100 mA meter in the battery circuit of the oscillator, but use only 6 volts or so on the oscillator. Turn on the station receiver and check to see that the oscillator is functioning. If it is not, vary the trimmer until it does oscillate. If trouble should be encountered, check to see that the battery polarity is correct and that the transistor is properly connected in the circuit. When oscillation is obtained, increase the battery voltage to 18 to 24 volts. Adjust the oscillator trimmer capacitor until oscillation ceases or the current drops to below 20 mA. Back off on this capacitor until the oscillator draws about 40 mA. The oscillator is now properly tuned. At this time, remove the meter from the battery circuit and place it in the key circuit. Adjust the capacitors in the final tank circuit to give minimum current with 300 volts applied to the plate of the final. When minimum current is obtained, the bulb should light dimly.

An alternate way of tuning up is to connect all voltages, place the meter in the key circuit and adjust the final for minimum current. Then, while observing the light bulb on the output, adjust the oscillator so that maximum brightness is obtained. At this point the oscillator current should be between 30 and 60 mA.

To put this rig on the air, connect a 50 or 75 ohm antenna or tuner to the output, place a 100 mA meter in the key circuit and tune to resonance. Then put the meter in the oscillator circuit and adjust the trimmer for about 40 mA.

This rig produces a clean signal with about 15 watts input. It should pose no constructional or operational problems that I know of; however, it does have one small quirk of which the builder should be aware. That is, that with 18 volts on the oscillator circuit, the grid drive is marginal and under some conditions, depending upon the transistor, crystal, etc., the grid drive may be just under optimum. This condition will be very obvious if it occurs since if an *rf* choke, meter or other small inductance is placed in the key circuit, the output from the final will increase. This occurs because under con-



Rear side of the circuit boards.

ditions of insufficient grid drive, the final becomes unstable and begins oscillating by itself, but locking to the frequency of the crystal oscillator. The rig can be used under this circumstance for CW operation, but if you should plate modulate this rig it would be wise to use 24 volts on the oscillator to be assured of sufficient drive.

Do not be alarmed if the transistor runs hot to the touch. With the heat sink as specified in the oscillator section, the unit will get very warm but will not reach a dangerous temperature. Without a heat sink, however, the transistor will be damaged.

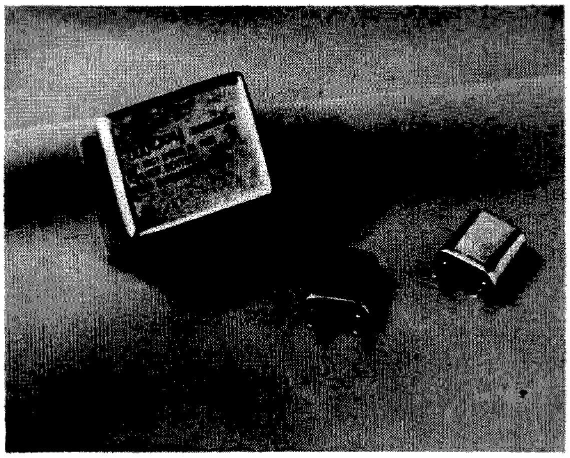
After you finish this little rig and decide that its time to start modifying it, keep in mind that since the three sections are built on plug-in boards there is no reason to modify or change your original circuits. Keep your original circuits intact and make all changes on separate circuits built on other plug-in cards. By doing this you will always have an operating version and you will always be able to make comparisons to your original circuits to see if you have made improvements or not.

. . . K1EUJ

Crystal Filters

Heart of Single Sideband

Frederick M. Clepper, W3RET
McCoy Electronics Company Division
Oak Electro/Netics Corporation



McCoy's Silver Sentinel quartz crystal filter, shown with the oscillator crystals supplied with all units.

Today, nearly all commercial SSB equipment utilizes quartz crystal filters. Ease of initial alignment, circuit stability and the "crystal clear" resultant signal are all characteristics of the filter approach to SSB generation. It hasn't always been this way, however.

Immediately following World War II—a time when most amateurs were eager to return to the airwaves—SSB was in its infancy. By mid-1947 only a handful of amateur stations were emitting the "Donald Duck" sounds on the lower frequencies. As one might expect, much controversy arose during these early sideband years and heated on-the-air discussions of SSB versus AM tended to prevail throughout the 1950's.

The technological approach then was to employ phasing-type designs commercially available with Barker & Williamson phase shift networks; this tended to make the carrier suppression job somewhat less tedious.

Crystal technique emerges

While this was happening crystal filters began to come into their own in communications receivers. It wasn't long before the advantages offered by the highly selective quartz elements became generally known by radio operators the world over.

Some of the more technically oriented amateurs of the early fifties discovered that military surplus low-frequency crystals could be used in construction of homebrewed SSB filters. It wasn't long before construction articles appeared in the amateur and trade press—significantly advancing the state-of-the-art—as a direct result of the staunch efforts of these pioneers. A quick examination of crystal operational characteristics reveals why this occurred.

Piezoelectric quartz, chemically silicon dioxide, possesses the ability of converting both electrical impulses into mechanical vibrations and mechanical vibrations into electrical impulses. It is through this means that quartz crystals can be used to control frequencies of radio transmitters and receivers. It is also by virtue of the piezoelectric effect that networks using quartz crystals can effectively pass or eliminate narrow bands or discrete frequencies in the radio spectrum.

Two basic filtering systems are being applied now to amateur equipment: 1) the switched filter method and 2) the switched carrier method.

The switched filter concept consists of two asymetrical or pure SSB filters switched above or below a common carrier frequency. **Fig. 1**, a simplified presentation of showing relative positioning of filters with respect to the carrier frequency, illustrates this point. The USB and LSB notations apply only to original frequency of sideband generation. Sideband inversion may result from hetrodyning to other than the original frequency.

The switched carrier concept is designed around an extremely selective, symmetrical bandpass filter. In this approach carrier frequency is switched between the upper and lower filter cut-off frequencies. **Fig. 2** is a presentation of the relative positioning of carrier with reference to the filter.

Switched carrier systems recently achieved wide acceptance in both receivers and transceivers. The advantages of this system include: 1) better out-of-band attenuation on both sides of the filter, 2) better stability

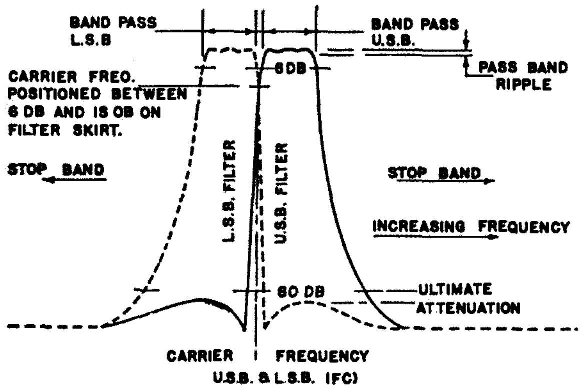


Fig. 1. Typical matched usb and lsb filters used in switched filter systems.

by eliminating the filter tracking problem of matched filters, 3) lower filter procurement cost, 4) less chassis space required and 5) oscillator crystal switching is operationally less critical than filter switching.

What to look for

An effective SSB filter must possess several distinct characteristics:

1) *Bandwidth.* The bandwidth of a filter is usually specified at −6 db. A typical SSB filter has a bandwidth of 3 kHz. Recent studies have indicated that a 2.1 kHz bandwidth is adequate for 100% intelligibility of the transmitted human voice. When one considers the adjacent channel or on-channel QRM on most ham bands, a 1.8 kHz bandwidth may find future acceptance.

2) *Shape factor.* Shape factor is usually specified as the ratio of the 6 db bandwidth to the 60 db bandwidth. An effective SSB filter should have a shape factor of 1.5:1 or less. For example, if a given filter has a 6 db bandwidth of 2.1 kHz, the 60 db bandwidth should have a maximum of 3.15 kHz. This specification is usually referred to in terms of the symetrical bandpass filter

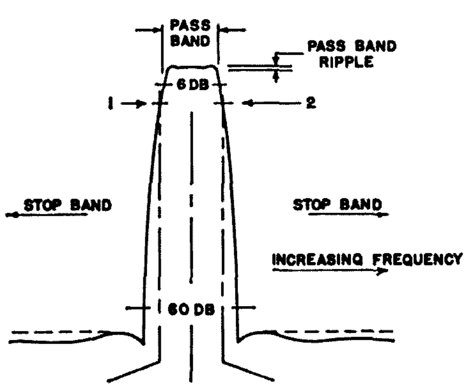


Fig. 2. Typical symmetrical bandpass filter used in switched carrier systems.

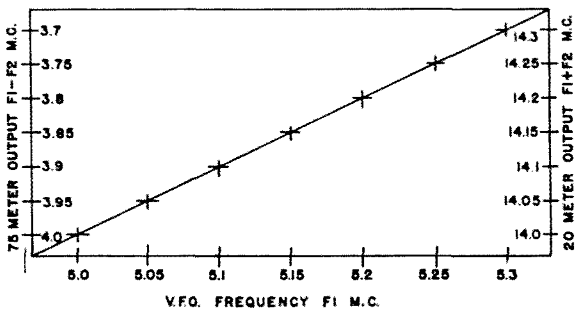


Fig. 3. Twenty and 75 meter frequency translation relationships to 5 MHz vfo.

used in the switched carrier technique. See **Fig. 1.** Pure SSB filters are most selective on only one skirt. In this case, discrete cutoff frequencies and their relative attenuations are usually specified.

3) *Ultimate attenuation.* The amount of attenuation given to signals appearing outside the selective skirt of the filter is normally referred to as ultimate attenuation. Generally −40 db is considered adequate as a design minimum. −50 db to −60 db ultimate attenuation is preferred.

Ham filter "Standards" arrive

In 1957, a 9.0 MHz symmetrical bandpass filter for amateur SSB use was introduced by McCoy Electronics Company. This filter was supplied with matching oscillator crystals for both upper and lower sideband operation and designated as type SSB-9. It was designed for a 6 db bandwidth of 2.7 kHz and a shape factor of 1.8:1, 40 db to 6 db.

The frequency of 9.0 MHz was chosen for this filter "first" because of the ease in hetrodyning to 20 to 75 meters with only a single conversion stages. **Fig. 3** is a graph of the 20 to 75 meter frequency translation relationships with a vfo operating in the 4 MHz range.

Popular demand for a filter of the SSB-9 type prompted design of a second generation filter series. The "Silver Sentinel" (McCoy type 32B1) and the "Golden Guardian" (type 48B1) evolved from the original SSB-9 designs.

The popularity of 9.0 MHz SSB filters has today spread throughout the world. VHF operators generally contend that high-frequency crystal filters were primarily responsible for the growth of SSB on the 50, 144 and 220 MHz bands. Manufacturers of amateur and commercial radio equipment have recognized the value of high quality crystal filters and are today producing amateur equipment capable of meeting rigorous commercial standards.

More than twenty years have elapsed since the birth of amateur SSB. Advances in state-of-the-art continue to tax the imagination. Amateur radio enthusiasts have played a major role in this progress and should be proud to have pioneered these advances.

. . . W3RET

Troubleshooting

Charles Jones K3PBY
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Pittsburgh, Pennsylvania 15235

Solid State Circuitry

"If something can go wrong, it will!" This saying hangs on the wall of my shack and also above my bench at work. To anyone involved in electronics it is a familiar happening. Some construction projects don't work at all after they are completed; others work in a half decent fashion; or a circuit decides to lay an egg after months of perfect operation, It's all part of the game we've all been through. Winning the game can be pretty tough though.

In this article I will try to give you some "down-to-earth hints and techniques to make the hard game of troubleshooting a little easier for you to win. I do not think it useful to explore the aspects of debugging vacuum-tube circuitry since most of us are familiar with these procedures. Instead, I will concentrate on methods of locating difficulties which arise in solid state circuitry.

Voltage Measurements

The output and input impedances of transistors often are much lower than for vacuum-tubes, therefore a more sensitive voltmeter must be used when you are working on transistor circuits, to read the lower voltages. And a 1000 ohms-per-volt VOM about useless for transistor work because its current requirements will upset many transistor circuits.

To see how important it is to use a sensitive voltmeter when making measurements in a transistorized circuit, take a look at the circuit of **Fig. 1.** Suppose we want to measure the voltage at the base of the transistor. Our schematic indicates it should measure 1.35 volts. If we use a 1000 ohms-per-volt VOM at 2.5 volts full scale, with a sensitivity of the meter resistance is 2500 ohms. What we are actually doing when we make a voltage measurement is putting the meter in shunt with the circuit being checked. In **Fig. 1** we see this will reduce the base resistance to an equivalent value under 2500 ohms. Right away we can see that the signal and DC voltages at the transistor will be very upset.

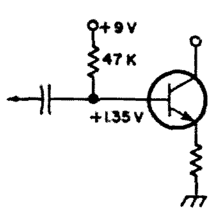

Fig. 1. *See Text.*

But if we use 20,000 ohms-per-volt VOM, this would be 50,000 ohms on the 2.5 volt range. This is a little better since the more sensitive VOM does not load the circuit as much. An 11-megohm would be best since it would have practically no effect on the circuit being tested.

When making voltage measurements in a solid state circuit, keep in mind that low meter ranges are required for low voltages. as an example consider a vacuum-tube circuit in which the plate voltage is supposed to be 300 volts. If for any reason there is a 10 percent decrease in plate voltage, we find 270 volts, a very visible change on a 350 Volt full scale range.

Now let us assume a transistor collector circuit in which we are looking for a potential of 6 volts. If this has dropped 10% we would find 5.4 volts. The percentage difference in both cases is the same and for the vacuum-tube circuit it would be very easy to detect a 30 volt difference. But a difference of 0.6 volt would be difficult to recognize, when working with low voltages on a high range scale. It is always good practice to choose a range where the meter needle will swing above the mid-scale point. This will help to make slight deviations in voltages more apparent.

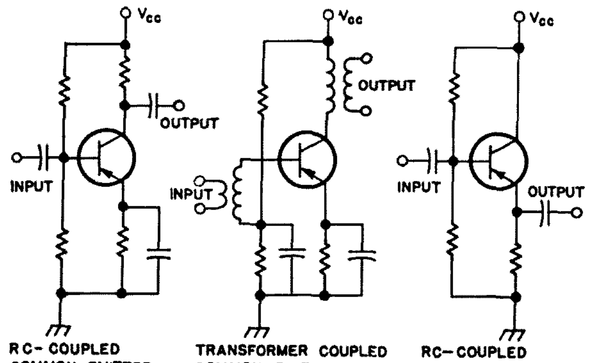

Fig. 2. Three common types of transistor amplifier circuits.

Voltage checking of transistor amplifiers is generally rather simple because they usually include an emitter resistor as part of the temperature stabilization network. By making voltage measurements across the emitter resistor we can quickly determine if the associated transistor and its circuit are functioning normally.

When checking the emitter resistor of an NPN transistor, we connect the positive lead of the voltmeter to the emitter lead and the negative lead to the common ground return point. For a PNP transistor the test leads must be reversed. Be careful in making voltage measurements across emitter resistors; it's easy to get fooled. You may be on the wrong range of your voltmeter. For example, if there is a defect in some component causing the voltage across the emitter resistor to be extremely low (0.2 volt or so), and you are on the ten volt scale of your voltmeter, it would be very easy to conclude that the emitter resistor voltage is zero.

The amount of voltage that you measure across the emitter resistor is a good indication of the trouble present in the circuit. For example, if you measure a potential of zero volts across the emitter resistor, it is likely the emitter resistor is open or disconnected. But take a good look to be sure the resistor is in good condition, and check the soldered joint.

Emitter resistors will seldom fail simply because they are tired. Usually some circuit malfunction causes them to overheat and open. A transistor collector-to-emitter short is one possible cause of a burned out emitter resistor. If you do find an open emitter resistor, or one which is greatly changed in value the associated transistor should be checked before the resistor is replaced.

Applying voltage of incorrect polarity to the circuit may also burn out the emitter resistor. If the circuit does not operate properly after you have corrected the supply polarity you should check each stage for an open emitter resistor after checking the transistor.

When measuring the collector-to-emitter voltage, be sure to use the correct meter polarity, depending on the type of transistor under test. The voltage you find should be around 50 percent of the collector supply voltage, or higher.

Because the base-emitter voltage is usually a few tenths of a volt, few circuit defects will cause the base voltage to be far from normal when measured with respect to the ground. Unless the base of the transistor is disconnected from its voltage divider network, or the network itself is defective, the base voltage can not change by a very large amount. Small variations in base voltage normally don't cause the circuit to become completely inoperative, unless the base-to-emitter current is abnormal.

Real Circuits

The three most common types of transistor amplifier circuits are illustrated in **Fig. 2.** For each circuit, it is easy to estimate the emitter, base and collector voltages to be expected if the transistor and other components are good.

If a high-beta transistor is used in the RC-coupled stage of **Fig. 2A,** the base current may be neglected in comparison with the bleeder current in the bias network consisting of resistors R1 and R2. The voltage at the base of the transistor can be calculated by solving the following equation:

$$\text{base voltage} = \frac{R2}{R1 + R2} \text{ x's collector voltage}$$

In the normal low-level amplifier stage with a quiescent collector current of approximately 1 mA, the base-emitter voltage is of the order of 200 millivolts in a germanium transistor, or 700 in V in a silicon transistor. The emitter voltage can be estimated by subtracting this voltage drop from the base voltage.

The emitter current is equal to the emitter voltage divided by the value of the emitter resistor, and the collector current will be about the same. The same analysis applies to the circuits of **Fig. 2B-C.**

Current Measurements

Direct current measurements sometimes provide useful clues to the operation of a circuit than voltage measurements. To make current tests, however, the circuit must be broken to insert the milliammeter. For this reason, current measurements are often used only as a last resort.

We can measure the emitter current by connecting dc milliammeter in series between the emitter resistor and the emitter electrode. To do this, remove the transistor from its socket, disconnect the emitter resistor from the emitter electrode and insert the milliammeter leads. If the transistor is soldered in to the circuit, simply disconnect the emitter resistor from its ground return and connect the milliammeter from the ground return to the open end of the resistor. You can also calculate the emitter current by measuring the emitter voltage and the resistor value.

Finding Open Circuits

When the emitter circuit of a transistor is open the collector current circuit is broken. The floating emitter lead will assume the same voltage as the base terminal, if the BC diode is not shorted. The-emitter-base bias voltage will be zero volts, and the base voltage to ground will be fairly normal.

If the base circuit of a germanium transistor opens, the transistor may go into thermal runaway. A silicon transistor will simply stop conducting under normal conditions, but may also go into the thermal runaway if operating temperatures are high.

When the collector circuit opens, the collector and emitter electrodes will assume the same potential, provided with normal base bias, the transistor has gone into saturation. Another condition which will cause the emitter and collector electrodes to have the same voltages is a shorted transistor. This is more likely to happen with power transistors.

Various Tests and Measurements

Always test a transistor or diode before inserting it in a circuit. It may be defective.

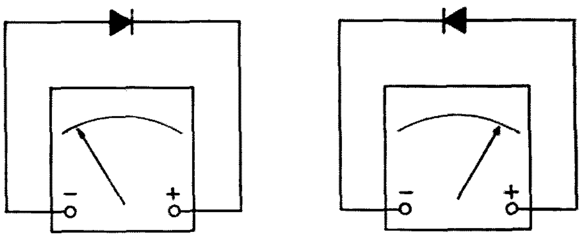

Fig. 3. Checking semiconductor diodes.

And transistors and diodes should be checked when they are suspected as a cause of equipment failure.

Semiconductor diodes are easy to check with an ohmmeter. Diodes should measure 25 to 500 ohms forward and about 250k ohms or more in the reverse direction (**Fig. 3**). If the diode is tested in the circuit the forward resistance should be about the same. But in most circuits diodes will only measure around 5k ohms in the reverse direction, due to added parallel circuit resistances. If you suspect that the diode is defective make a final check on the reverse resistance with one end of the diode disconnected from the circuit.

You can also make rough checks on transistors with your ohmmeter. If the transistors are not in sockets or cannot be easily removed from the circuit you do not have to disconnect them.

A transistor is basically a pair of diodes placed back-to-back. We can take advantage of this fact for testing, simply by measuring the forward and reverse resistances of the transistor electrodes.

The first step is an ohmmeter test with the collector-base electrodes reverse biased. This is easily done whether the transistor is an PNP or NPN type. Try both directions across the collector and base to find which gives the highest resistance reading. When you have located it, hold the meter leads to the collector and base terminals in place.

Next, observe the resistance reading and then short the emitter to the base; the resistance reading should not change. Remove the ohmmeter lead from the base electrode and connect it to the emitter lead. Now short the emitter to the base; the resistance reading should increase.

If a transistor does not respond as described, it probably is defective. However, weak units, or those which have leakage between elements, might test satisfactorily. These basic tests only indicate when a transistor is completely inoperative.

Conclusion

Troubleshooting solid state circuitry is sometimes very different from troubleshooting vacuum-tube circuitry. A few points are outlined in our discussion where the testing calls for special precautions or techniques, and some other debugging procedures are much the same. Locating solid state circuit problems should not present much difficulty to the radio amateur who is familiar with basic troubleshooting procedures and solid state theory.

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Bibliography

Leonard Lane, *How To Fix Transistor Radios and Printed Circuits—Vol. 2*, New York, Gernsback Library, 1959.

A Real "Big Switch"

When you hear a ham make a comment about pulling the "big switch" in most cases he means he will spend the following several minutes turning off an assortment of receivers, transmitters, scopes, calibrators etc. Some few of us actually cut the main breaker, but that too has disadvantages, there being some items which should remain on 24 hours a day. (including some rigs)

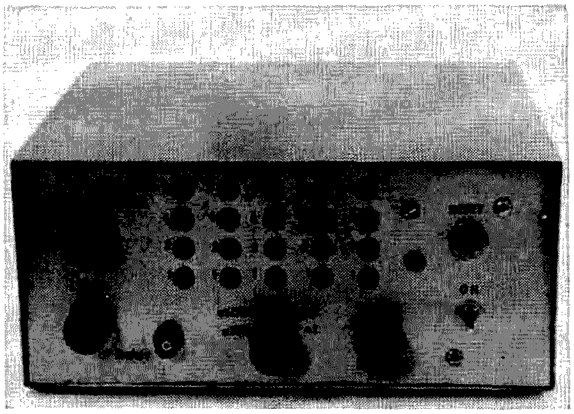
There are several ways of approaching this problem, the simpliest being two "convenience outlets" mounted on the main rig power supply. One is attached directly to the incoming power line. This circuit is used for clocks and other items which are left on all the time. The second outlet is wired across the primary of the power transformer so that it is energized with the rig. This setup should only be used for devices drawing small amounts of current lest the fuse or switch give up under the extra burden. For higher power, install the outlets as described, but in an external box install a heavy duty 117vac relay and as many outlets as required by the equipment to be controlled. The power for the relay coil only is derived from the rig, a separate heavy duty line cord being connected in series with the normally open relay contacts and the outlets.

We now have a method of turning off power to the station by means of a single switch—the one already on the rig. You can comment about pulling the "big switch" and be overstating the facts only very slightly.

. . . WAØABI

Integrated Circuit Frequency Counter

Wes Votipka WB6IBS
Consumer Applications
Fairchild Semiconductor
313 Fairchild Drive
Mountain View, Ca. 94041



A simplified frequency counter that can be used in checking the drift of a variable frequency oscillator can be easily built at a minimum of cost thanks to the large availability of low-cost integrated circuits.

The simplicity of design using the integrated circuit binary system uses no transformers with their associated turns ratio and impedance ratio to worry about or wind; there is no filament to run, shield and bypass at each end; and there are no ground loops that always seemed to be included in equipment built in the past.

The basic block diagram for the digital frequency counter is shown in **Fig. 1.** A standard frequency is needed as a reference; a pulse shaping network for the input signal; a counting and display system; a power supply and a control (program generator) to sequence everything properly.

The final design must meet these requirements:

1. Count frequency to at least 10 MHz.
2. Have reasonable accuracy, .001 per cent or better.
3. Use low cost and readily available integrated circuits.
4. Line operated regulated power supply with options for use with auto battery.
5. Should have a five-digit readout with panel lights because Nixie tubes are too expensive and require additional integrated circuits for decoding for a decimal readout.
6. Variable readout display time.
7. Period count for additional flexibility.
8. Self check feature.
9. P. C. Board for repeatability and trouble free wiring.
10. A general description of the circuit complete enough for the interested person to get an understanding of the logic operation and design to assist him in modifying the counter to use whatever integrated circuits he might have available.

The integrated circuit frequency counter to be described meets all of the above requirements and exceeds the minimum frequency specifications in that it has a direct readout to 20 MHz. The total cost of new, off-the-shelf, integrated circuits is approximately $120.

First, it's best to examine the basic parts of a counter to see how they work, and then connect them to make them count. The basic unit (counter module) must contain some means of sensing a change at its input. The module should be able to store or hold this information so that it can displayed on a readout device. The unit chosen for this function is a flip-flop, a device that has only two output states, a "one" and a "zero." **Fig. 2** is the schematic of a μL 923 JK Flip-Flop.

Fig. 3 is the logic symbol of the device

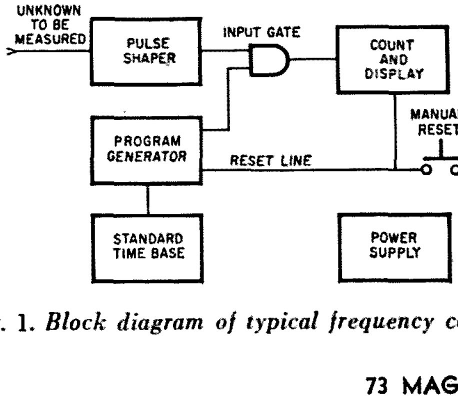


Fig. 1. Block diagram of typical frequency counter.

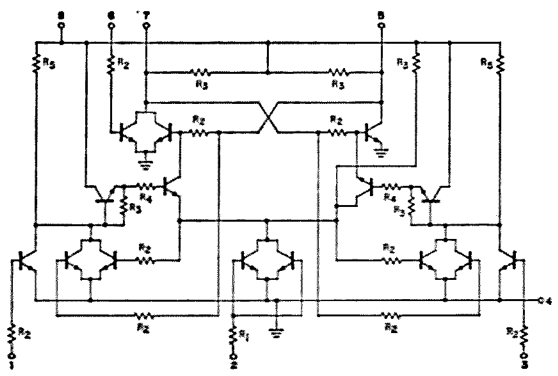


Fig. 2. The schematic of a uL 932 JK Flip-Flop.

with the truth table for the μL 923 outlined in **Fig. 4.** A lamp is used in series with a transistor connected to ground as a lamp driver and when connected produces the counter module shown in **Fig. 5.**

When connected in this manner, the transistor would draw excessive base current, so 470-ohms resistor is added in series with the base to limit the base current to a safe value. The lamp will now light every other time the input switch (SI, in **Fig. 5**), is closed. When five of these are connected together (as shown in **Fig. 6**) there will now be a counter that can count, hold and display up to a total count of 31. On the next input all lamps go out and the count starts over.

This idea can be carried on as far as one cares. That is twelve of the basic modules connected as such would give a total count of 4,095. In the above example the individual must decode the lamps that are lit. Assume all lamps are out, on the first pulse lamp No. 1 lights, on the second pulse it goes out and lamp No. 2 lights, on the third pulse both 1 and 2 are lit and so on. The secret is to add the value of the lighted lamps to arrive at the correct count. While this binary system works well, most people have been taught to think in the decimal or base 10 system, therefore a counter is needed to display the number 9 count then on the next input for all the lights to go out. This can be done as in **Fig. 7A.**

In order to accomplish this 4 flip-flops and a μL 914 are used (**Fig. 7B**) with dual two gate input connected to form a decade (or divide by 10) counter.

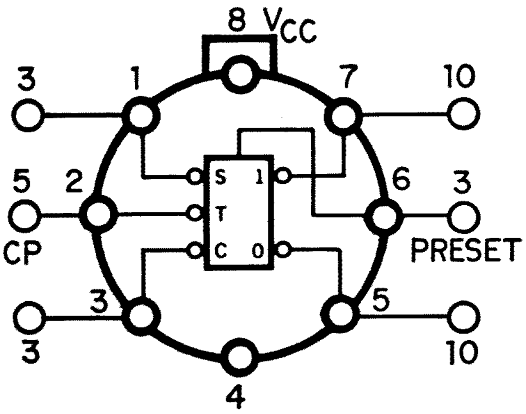


Fig. 3. The logic symbol of the uL 923.

FUNCTIONS

SET (1)	CLEAR (3) t=n	OUTPUT (7) t=n+1
H	H	X^n
H	L	H
L	H	L
L	L	$\overline{X^n}$

H = HIGH

L = LOW

X IS THE OUTPUT STATE AT TIME n

A HIGH ON PIN 6 WILL PRESET OUTPUT PIN 7 LOW

Fig. 4. Truth table.

Truth Table

Decimal	Input	Lamp Number #1	#2	#3	#4
0	0	0	0	0	0
1	1	•	0	0	0
2	0	0	•	0	0
3	1	•	•	0	0
4	0	0	0	•	0
5	1	•	0	•	0
6	0	0	•	•	0
7	1	•	•	•	0
8	0	0	0	0	•
9	1	•	0	0	•

The above truth table is the proof of this connection. By connecting five of these decades together one has the ability to count to 99,999.

The maximum speed of the μL 923 is 2 MHz, and a μL 926 has a maximum speed of 20 MHz, with one decade using μL 926s and four decades using μL 923's ability to count to the maximum rate of the μL 926 is reached—in other words a 20 MHz counter.

For a reference a stable time base is required. A good choice is a 100 kHz crystal.

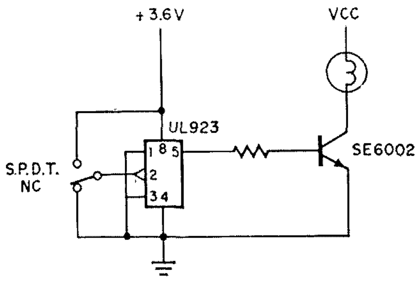


Fig. 5. A lamp used in series with a transistor connected to ground as a lamp driver produces the counter module shown.

Fig. 8 shows the 100 kHz crystal oscillator used.

The μL 914 is connected as a multivibrator with the crystal connectel in one of the feedback paths. The output of the crystal oscillator has to be reduced to lower frequencies to be useful. The μL 958 decade divider is used here in the interest of space. The μL 923 decade divider of **Fig. 7** could be used as well if space is not a prime consideration. The logic diagram of the μL 958 is shown in **Fig. 9.**

Five of these decade dividers are required in this system in addition to three μL 923 flip-flops to give the required timing pulses.

The next circuit to be considered is the input-pulse shaper and gate. The pulse shaper is required to convert the input waveform to a square wave with rise and fall time faster than 200 milliseconds. The Schmidt trigger meets this requirement. The input to the Schmidt trigger is rather high (1.7 V) so it must be preceded by an amplifier. The complete input circuit is shown in **Fig. 10.**

The 5K pot serves as the input sensitivity control. The diodes D1, D2, and D3 are required as level shifting devices and can be any silicon devices such as the FD 100.

The program generator is the most complicated part of the counter circuitry. **Fig. 11** is a diagram of this unit.

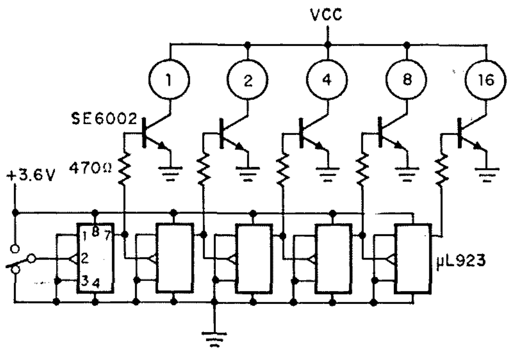


Fig. 6. Five counter modules connected together can count, hold and display a total count of 31.

To describe its operation, assume the manual reset button is pushed, all lights in the counter go out indicating no count is started and it is ready to count. The first positive going pulse (from the time base generator) on pin 2 of gate G1 drives its output pin 7 in a negative direction toward ground. This negative pulse causes flip-flop 1 to change state from a high at pin 5 to a low at pin 5, the low on pin 5 allows the input gate in the pulse shaper to pass the pulses to be counted to the counter. At the end of the first pulse G1, pin 2 is no longer held at a high level (approximately +3 V) and returns to ground allowing pin 7 to go high. As the μL 923 flip-flops do not toggle on a positive going pulse, flip-flop 1 does not change state and the pulse shaper gate is enabled (held open) to allow pulses to pass. When the second pulse from the time base

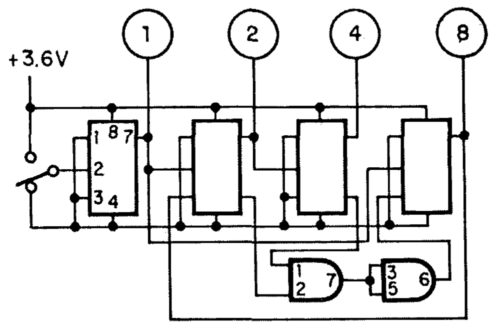


Fig. 7A. See text

generator arrives at the input to G1, it again drives G1 pin 7 low which causes flip-flop 1 to change state. When this happens flip-flop 1, pin 5, is high therefore the pulse shaper gate is blocked and no more pulses are allowed into the counter. At the same time pin 5 goes, pin 7 is driven negative. These actions cause flip-flop 2 to change state with flip-flop 2, pin 7 going from low to high. The high on pin 7 is applied to pin 2 of G1 which inhibits or blocks its input, therefore the count is now displayed until a reset pulse is initiated. G2 and G3 are connected as a one-shot to control the gate lamp and D1, the gate lamp driver. This lamp is lit when the pulse shaper gate is enabled (opened) to let pulses into the counter. The lamp stays lit for approximately 200 milliseconds. The flashing gate lamp is an indication that the counter is either ready or is counting depending on the presence of a signal at the input to the pulse shaper.

Gate G4 and driver D2 are also connected as a one shot to automatically reset the total

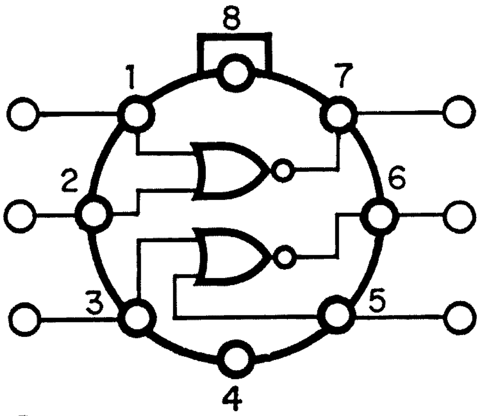


Fig. 7B. See text.

frequency counter depending on the position of the display time switch. In this design the display time is one, two and four seconds. The actual display time is the time selected by the display time switch less a two-pulse time selected by the time base switch. As an example assume the time base switch is set on 1KC (1 millisecond) and the display time is 1 second. The count will be for one millisecond and the display for 999 milliseconds. This is very close to the time selected by the display time switch, but if the count is for one second as would be used to count very low audio frequencies then the display time switch should be set for either two or four second display for a reading because in the one second display time position the counter will count for one second and then immediately reset at the end of one second period, resulting in a continuous count and no display time for readout.

Persons interested in building the complete counter or only part of the circuit should start with the basic counter module of **Fig. 6,** which can be expanded to as many flip-flops and lamps as needed for other applications.

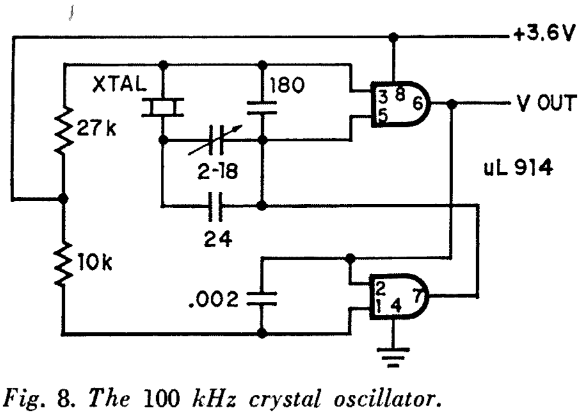


Fig. 8. The 100 *kHz crystal oscillator.*

The average toggle or push button switch is too noisy for this application so one should not try to use one to control the basic counter module. The one shot portion of the gate lamp circuitry of **Fig. 11** is shown in **Fig. 12** and should be used in place of the switch to drive the basic counter module.

The standard coding used on the μL 900, μL 914 and μL 923 is that pin 4 is ground and pin 8 goes to +3.6 V. On the μL 926 pin 5 is ground and pin 10 goes to +3.6 V.

Another point to remember is that all unused input pins must be grounded for noise immunity. As a point to remember it should be noted that all pin numbering is done from the top. Remember when working from the bottom of the board they are still numbered like the tubes we are familiar with.

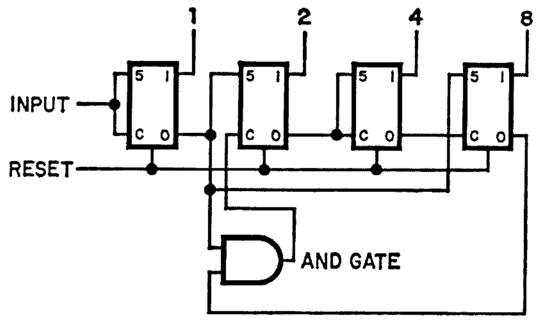


Fig. 9. The logic diagram of the uL 958 *decade divider.*

After becoming familiar with the wiring and operation of **Fig. 6,** change the layout to the wiring of **Fig. 7** to check the proof of the truth table. This table is an informative display and is the key to the readout of this frequency counter.

Several of the basic counter modules may be joined by connecting pin 1, the carry output, of the first module to pin 2, the count input, of the second unit. These connections should be repeated as additional modules are added to the existing ones. By jumping pin 6 of all of the μL 923s together and adding a spring-loaded normally opened switch in series with this line to the +3.6 V line, all units may be set to "O" by momentarily pressing the switch to turn off all the lamps.

The next thing to build is the 100 kHz crystal oscillator shown in **Fig. 9.** The operation of the oscillator depends on the tolerance of the .002 μF capacitor and this value may need to be adjusted slightly to insure crystal control of the oscillator. With the crystal out of the circuit the output at pin 7

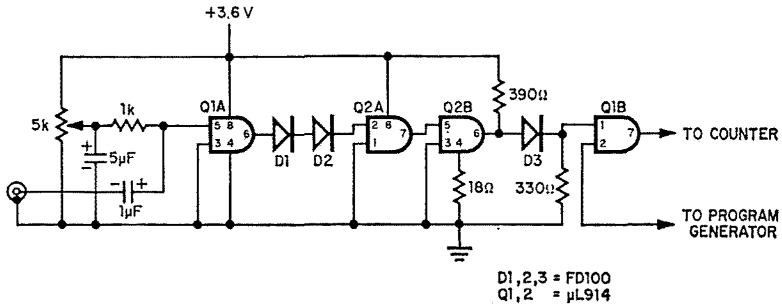


Fig. 10. The complete input circuit to the Schmidt trigger.

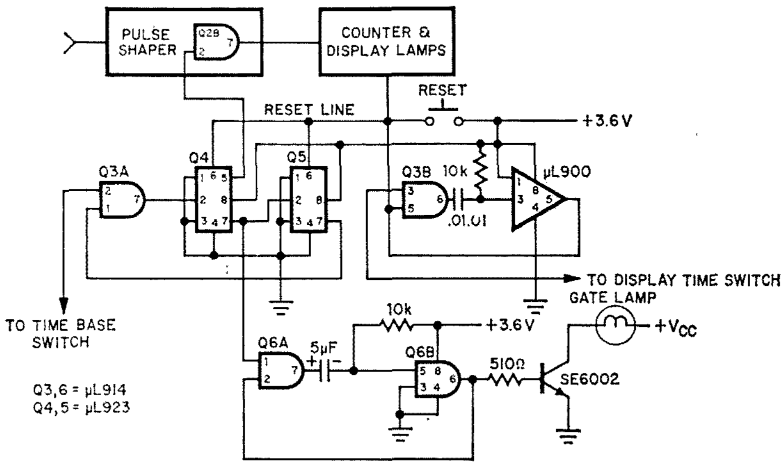


Fig. 11. Diagram of the program generator.

should be a square wave with a free running frequency of about 150 kHz. This can be checked on the station receiver. The next step is to put the crystal back in the circuit and adjust the trimmer to zero beat with W.W.V. when slightly coupled to the antenna. A μL 914 should be used as a buffer amplifier to prevent loading of the oscillator as shown in **Fig. 13.**

There are several alternatives to consider in place of the μL 958 decade dividers if one is not limited by space requirements. One alternative would be to use the basic counter module of **Fig. 7A.** Another would be to use the minimum hardware type decade divider shown in **Fig. 14.**

A digital type divider should be used in the time base section as there has not been as yet developed a reliable, low-component count, regenerative or step type divider that can compare with the digital type for temperature, component tolerance and frequency stability.

Fig. 15 is the schematic of the complete integrated circuit frequency counter.

The function switch S1 selects the mode of measurement. In position 1 check the output from Q10, the first decade divider, a 3 V P-P pulse is applied to a resistive voltage divider and coupled through a .01 μF capacitor to the input of the pulse shaper. The level is set at approximately 53 millivolts to allow a setting of the sensitivity control to the most sensitive position for future measurements.

Position 2 "**FREQ**" is used for most frequency measurements. Some adjustment of the sensitivity control may be needed to handle very small or very large signals. Some consideration should be given the dc level applied to the input jack. The 1 μF, 50v input capacitor should be changed in the event the unit is used exclusively with tube type circuits. However an external dc block-

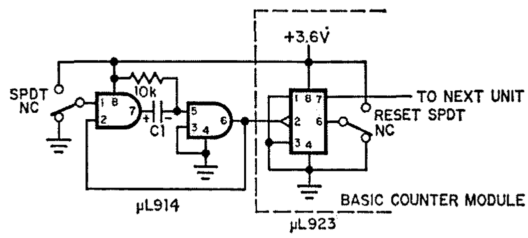


Fig. 12. "Noiseless' switch used to control the basic counter module.

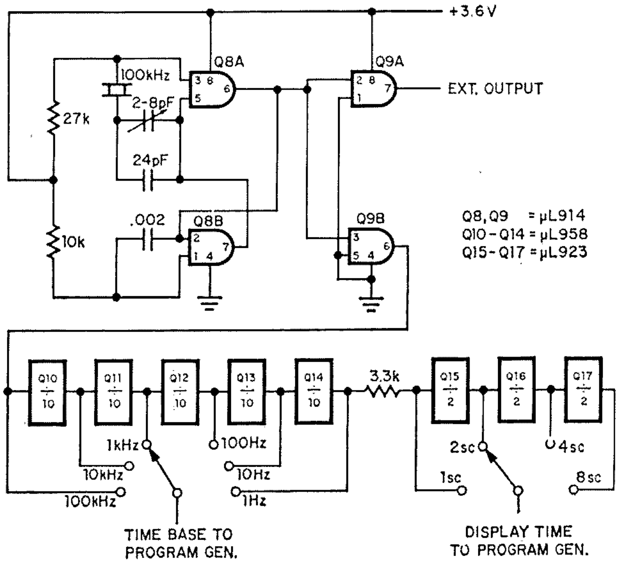


Fig. 13. A uL 914 used as a buffer amplifier to prevent overload of the oscillator.

ing capacitor may be used, and should always be used when in doubt.

Position 3 "PERIOD" is the most versatile one. In this mode the input to the pulse shaper and the program generator portions are reversed. A pulse applied to the input jack opens the gate Q 1B allowing the pulses, selected by the time base switch S2, into the count register. These pulses are accumulated in the register until the next pulse arrives at the input jack which inhibits (turns off) the gate Q 1B. The accumulated count is now displayed for readout.

The reciprocal of the readout is the period of time between the input pulses.

$$\text{TIME seconds} \qquad \frac{1}{\text{Readout}}$$

As an example a readout of

$$1000 = \frac{1}{1000} = 1 \text{ millisec.}$$

$$200 = \frac{1}{200} = 5 \text{ millisec.}$$

$$25 = \frac{1}{25} = 40 \text{ millisec.}$$

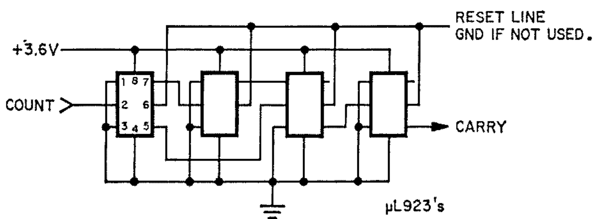


Fig. 14. The block diagram of the standard time base generator.

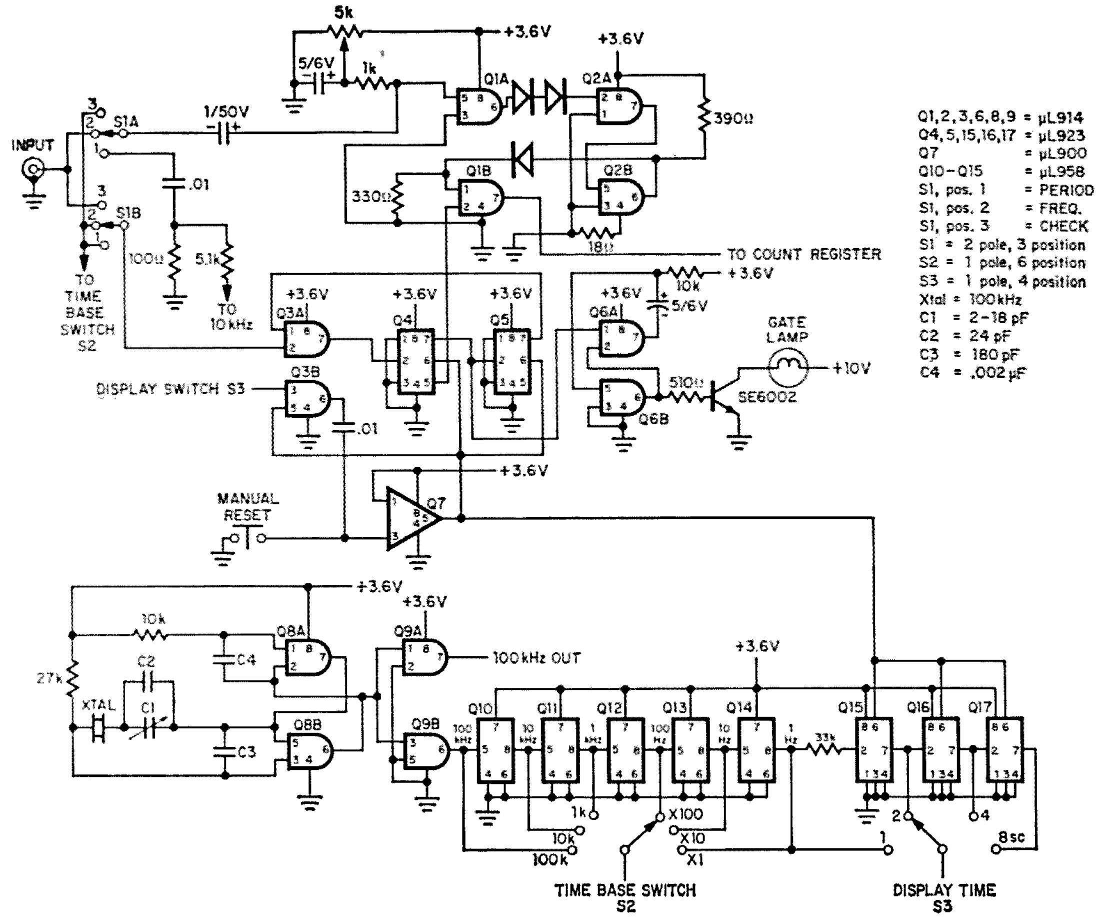


Fig. 15. The schematic of the complete integrated circuit frequency counter.

One use of the PERIOD position is to measure frequency or occurrances too slow to count reliably. The doppler frequency of Oscar as it passed overhead may be measured in this manner. Other uses could be as a digital readout automobile tachometer, timing clock at the drag strip and a chronograph to measure the speed of a bullet.

A voltage-to-frequency converter now in the prototype stage looks promising. With a conversion factor of 100 Hz volt the unit becomes a digital voltmeter with possible uses as a digital volt, ohm, milliamp meter and a digital thermometer by the addition of a thermistor.

Another idea in the prototype stage is a high frequency divider or scaler that will allow a direct readout to 100 MHz.

While all of the possible uses of the basic integrated circuit frequency counter have not been covered it's easy to see how a person can get involved in something like this where its uses are limited only by one's imagination.

The power supply schematic is shown in Fig. 16. The connections of the secondary may appear strange, but connected in this manner it provides the required outputs, where a conventional connection for these outputs require a dual winding on the secondary. Diodes D1, D4 and C2 form a capacitor input bridge circuit with C2 charging to the peak value of the secondary voltage, approximately 6.5 volts underload. Diode D5 and CI form a half-wave capacitor input supply with approximately 12.5-volt output underload. R1, D6 and Q1 forms a series regulator for the 10-volt line to the lamps. C3 is needed to suppress the noises generated as the lamps are switched off and on. Q2, Q3 and D7 form a series regulator for the 3-6-volt line. R2 is connected between D6 and D7 with D6 as a constant voltage point. R2 acts as a constant current source for D7. The output of the 3.6-volt line has excellent regulation. C4 is needed for additional noise suppression.

For operation from an auto battery the

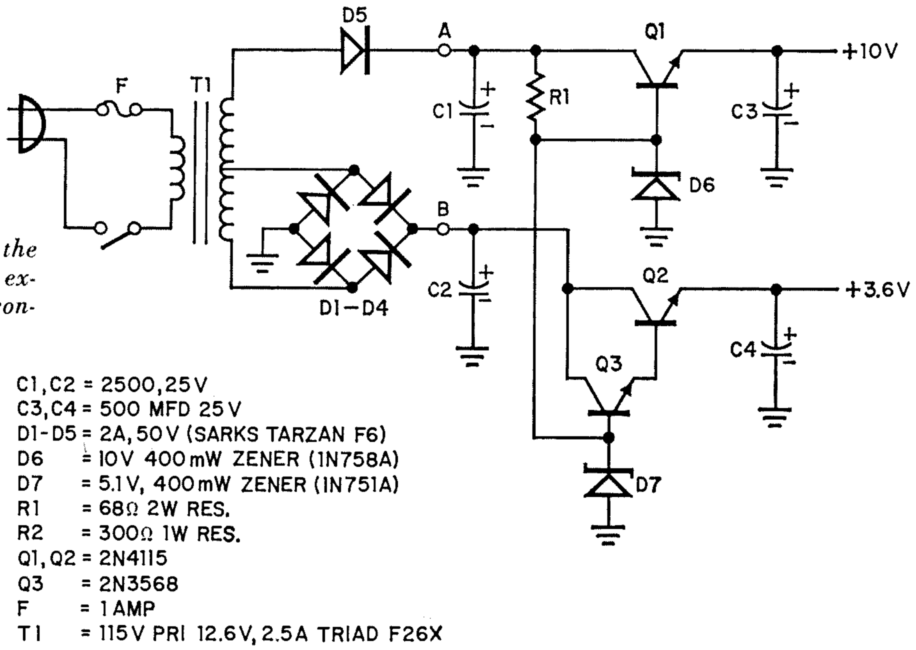


Fig. 16. Schematic of the power supply. See text for explanation of the unusual connections of the secondary.

power supply is broken at points A and B and the auto battery adapter is connected to these points.

The photos show the mechanical layout used in the model. The enclosure, the front panel and sub chassis is formed of copper clad board. The sub chassis is soldered to the front panel after the holes are drilled for the switches and lamps. All components of the power supply are mounted on the aluminum channel, which is bolted to the front panel and the enclosure bottom, resulting in a very light but rigid assembly.

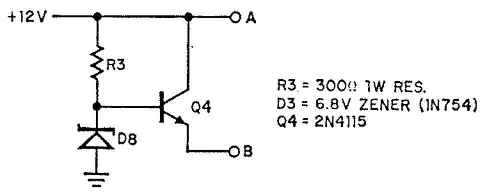


Fig. 17. Auto battery adaptor.

The dimensions of the enclosure are 4″ high, 9″ wide and 9″ long, with a net weight of 5 pounds. While there may be manufactured frequency counters on the market with better appearance, better readout systems, higher count ability and oven controlled crystals, their cost puts them out of reach of the serious experimenter. This unit shows what can be done, without a large engineering effort, to utilize readily available ICs in a project of this magnitude.

A complete set of etched and drilled boards are available from the author for $22.50 plus 50 cents postage in the U.S.

. . . WB6IBS

"CV" Transformers for Ham Applications

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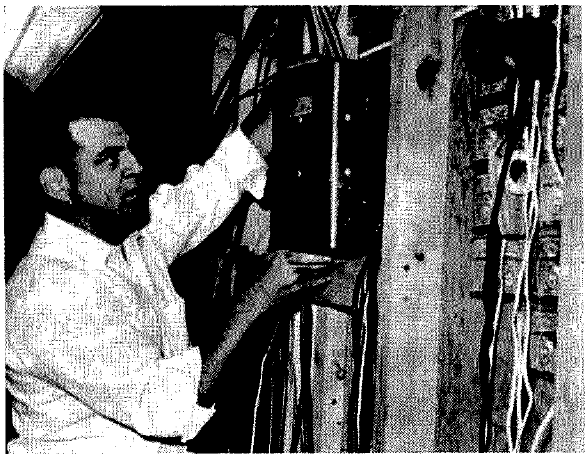
Over the years many of us have encountered problems caused by power line voltage fluctuations, and most of us have simply assumed that line variations are something with which we have to live.

In nearly all private homes today are literally scores of electrical appliances which are used intermittently, thus causing load variations. These electrical loads include furnaces, washing machines, dryers, air conditioners, not to mention XYLs' irons, toasters, vacuum cleaners, refrigerators and hair dryers. When these items are considered in their normal on/off circuit enivironment, it is small wonder we amateurs notice ham shack lamps flickering from time to time.

If a recording voltmeter were installed for 24 hours in the ac line feeding the station, most hams would be amazed at the voltage changes. They would consist of spikes, dips, surges and high-low variations, well removed from the nominal voltage for which amateur equipment was designed. If the QTH is an older building, an apartment, industrial area or farm, this condition usually becomes even more pronounced.

Although most amateur electronic equipment has some built-in regulation for vfo's and various oscillators, line variations still exist which can have a serious effect on filament emission and plate voltages. High voltage (above the nominal) shortens tube and equipment life by overstressing components. Low voltage results in less than peak performance while transients can cause disruptive action and possible frequency shift.

Amateurs can correct these variation problems—without requiring that they own their own utility to accomplish it—by examining the various types of line regulators now available. These include electronic, in-



Author WA9CQN mounting Sola Electric 500 va constant voltage transformer on wall near outlet box supplying ac power to radio room.

duction, electro-mechanical, electronic mechanical and static-magnetic. The static-magnetic constant voltage transformer is one of the best means of voltage regulation. It provides close regulation without the need of complicated circuit components. Additional advantages are as follows:

1. Maintain ± one percent regulation with transient or continuous primary variations as great as ± 15 percent.
2. Self protection is provided against short circuits in the load.
3. Both physical and electrical isolation is provided between input and output circuits. No manual adjustments are required because there are no moving parts; completely automatic continuous regulation is provided.
4. Response time is usually less than 25 milliseconds at 60 Hz plus preventing irratic VOX or relay operation.
5. Has inherent built-in characteristics of current limiting to protect the load.
6. Comes in a variety of step-up or step-

down designs ranging from 15 va to 10 kva.

How transformer works

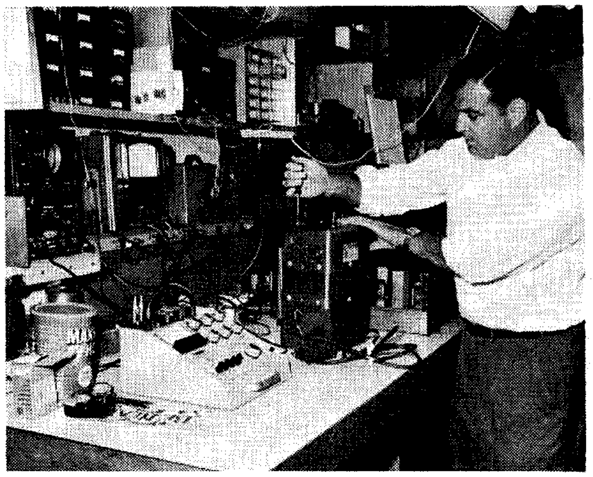
A constant-voltage transformer has a magnetic core structure different from conventional transformers. It has a magnetic shunt with a fixed air gap interposed between the primary and secondary windings. The secondary winding is shunted by a fixed ac capacitor. Upon application of primary voltage, the secondary voltage increases to the point at which that portion of the magnetic core directly under the secondary winding approaches saturation due to the capacitative load connected across the secondary winding.

As the core approaches saturation, it cannot carry much additional magnetic flux. The increase in secondary voltage is less than any proportional increase in primary voltage. Thus, a condition of relative stability of secondary voltage is reached. Over the range of specified primary voltage, the core under the secondary changes very little for this range of primary voltage. Due to the magnetic shunt between the primary and secondary windings, that part of the core under the primary is not saturated.

To equalize the small effect of increasing primary voltage on the secondary, a compensating coil is wound over the primary coil and is connected in series with the secondary load circuit—but out of phase with the secondary. Result is that as primary voltage increases beyond the design voltage, the voltage in the compensating coil also increases. Since it is out of phase with the secondary voltage, however, it subtracts (from the secondary voltage) an amount equal to the slight increase induced in the secondary winding by the increase of primary voltage. Likewise, when the primary voltage decreases, the compensating coil voltage decreases in proportion to the primary voltage, and subtracts from the secondary voltage. The design is such that the vector sum of the compensating coil voltage and the secondary voltage is practically constant throughout the design range of input voltage.

Using the CV

When the constant voltage transformer is overloaded in excess of its rated load, a point is reached where the output voltage drops to approximately zero. Due to the magnetic shunt in the transformer, its output current is limited. With excessive load current, the effect of the ac capacitor is lost; secondary flux opposes primary flux to de-magnetize the secondary core leg, and the output voltage collapses, limiting short-circuit current to approximately 150 percent of full load.



Here Bill is removing Sola CV transformer to facilitate connection of adapter (seen with cabling attached in front of CV) for use with standard ac line plugs. Use of adapter precludes necessity for permanent installation, cable hookups, etc.

From this it begins to become clear why the addition of a constant voltage transformer is such an asset to the ham shack. The same transformer can be used additionally to supply constant voltage to the workshop thus insuring that the readings and indications obtained from test equipment remain constant.

Most electronic supply houses carry a fairly complete line of constant voltage transformers. In case of a special requirement, they can also order to individual specifications.

Since most CV transformers are rated for resistive loads (unity power factor), care must be taken in selection of proper rating. Charts are available to show how much to derate the transformer if power factor is less than unity. Normal constant voltage transformers also have some harmonic content in the output. If the equipment in question requires a wave shape close to a sinosoidal, a harmonic-neutralized constant voltage transformer should be specified.

Stabilize that station voltage, cut maintenance costs and increase your equipment's component life.—today! . . . WA9CQN

A Space Communications Odyssey

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The Star Trek episode concerning the adventures of three radio operators named Tom, Dick, and Harry which I am about to relate could some day be true. It is based on the well-known principles of the special theory of relativity applied to fast-moving rocket ships plying the depths of interstellar space. Before proceeding with an account of the unusual events experienced by the three radiomen, permit me to introduce some elementary concepts of the theory which arise when high speeds are encountered.

One of the pillars on which relativity theory rests is Einstein's dictum that:

> The velocity of electromagnetic radiation in space is the same for all observers[1] regardless of their individual motions; furthermore, no object can travel faster than this radiation, 186,300 miles per second.

According to Einstein, if v_A and v_B represent the space velocities of two observers, A and B respectively, their relative velocity, v_{AB}, is

$$v_{AB} = \frac{v_A + v_B}{1 + \frac{v_A \cdot v_B}{c^2}}$$

where c equals the velocity of electromagnetic waves. This formula results from the linking together of the fourth dimension, time, with the three dimensions of space. If A's and B's velocities are insignificant in comparison with the velocity of light or radio waves, which is normally the case on earth, formula (1) reduces to the usual expression, $v_{AB} = v_A + v_B$. Thus if two planes are traveling in opposite directions at 500 miles per hour, their speed relative to each other is 500 + 500 = 1000 mph. On the other hand, if two bullets could be fired in opposite directions at speeds of 100,000 miles per second and 150,000 miles per second respectively, their relative velocity, v_{AB}, is *not* the sum (= 250,000 mps) but 145,350 mps as calculated from formula (1). Let us consider the extreme situation. If two beams of light are transmitted simultaneously in opposite directions from the same point, they will recede from each other at the relative velocity of 186,300 mps (= c) and not at 372,600 mps (= 2c) according to formula (1). There is no way of traveling faster than the speed of light.

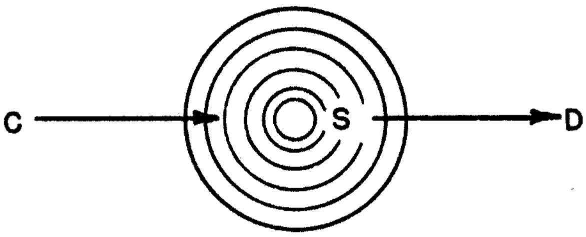


Fig. 1. The Doppler Effect.

Another well-known result of relativity is that time is *slowed* by the Lorentz contraction factor, $\sqrt{1 - \frac{v^2}{c^2}}$, where $\frac{v}{c}$ is the observers velocity relative to that of light. This slowing down of time for a fast-moving observer is called time dilation. It is unimportant for all ordinary speeds $(\frac{v}{c} \sim 0)$ but must be reckoned with at speeds which are significant fractions of the velocity of electromagnetic waves. Another way of stating this result is: the faster one travels relative to the speed of light, the slower his clock runs. This affects all physical phenomena, such as electromagnetic or atomic, in which the time element enters as a factor.

There is one more phenomenon to consider before leaving the earth for a flight to the stars, viz., the Doppler Effect. If observer C is moving toward a fixed source, S, which is radiating on a frequency, f_o, as shown in **Fig.** 1, he will encounter more wave crests passing him each second than if he were standing still. If observer D is moving away from the stationary source, S, he will in turn record fewer wave crests

[1] An observer may be defined as a person who clocks the time of an event or happening in his moving frame of reference.

passing him each second. C will have to tune his receiver to a slightly higher frequency and D to a slightly lower frequency in order to receive the signal from S, the amount of frequency shift being proportional to the observer's velocity. In reality, it is immaterial whether the source is in motion, or the observer, or both. For ordinary velocities the Doppler formula is given by

$$f_r = f_o\left(1 - \frac{v}{c}\right) \quad \text{receding} \tag{2a}$$

$$f_a = f_o\left(1 + \frac{v}{c}\right) \quad \text{approaching} \tag{2b}$$

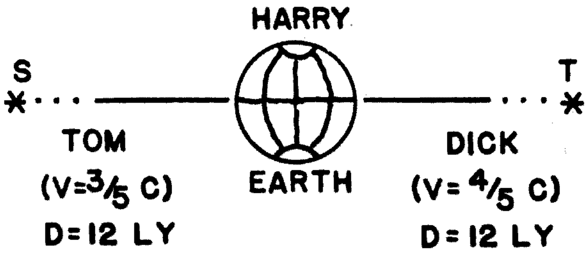
where f_o is the station's transmitting frequency, f_r is the received frequency which is slightly lower than f_o for a receding observer, f_a is the received frequency which is slightly higher for an approaching observer, and $\frac{v}{c}$ is the velocity of the observer relative to that of the radiation. The Doppler formula is widely employed in astronomy and in physics in the study of radiating moving bodies. Use is also made of the Doppler Principle to provide velocity and distance determinations in aircraft, lunar soft-landers, and in the tracking of space vehicles by means of Doppler-radio or Doppler-radar techniques.

When the speed of approach or recession is appreciable, the Doppler expression above must be modified according to relativity theory by dividing the frequency f_r or f_a by the factor $\sqrt{1 - \frac{v^2}{c^2}}$ because the observer's clock is running slow by this amount thereby increasing his count of wave crests per second. As an illustration of the Doppler Principle, imagine a rocket vehicle leaving the earth at a velocity of 10 miles per second. If the rocket's transmitting frequency while on the launch pad is 100 MHz, its received frequency on earth during flight will be 99.9946 MHz from formula 2a. However, if it were possible for the rocket to leave the earth at a speed of 10,000 miles per second, the received frequency would now be 94.7700 MHz which is obtained by dividing 100 $(1 - \frac{v}{c})$ = 94.6323 MHz by the contraction factor, $\sqrt{1 - \frac{v^2}{c^2}} = .99712$

where v = 10,000 mps and c= 186,300 mps.

We are now ready to see what happens to a radio operator departing from the earth at high speed for a round-trip journey in a rocket ship to a distant star. Tom is planning to leave the earth on a round-trip flight to star, S, 12 light years distant at a rocket speed of three-fifths the velocity of light ($v = \frac{3}{5}c$). At the same time, Dick will leave the earth in the opposite direction on a round-trip voyage to star, T, also 12 light years distant at a rocket speed of four-fifths the velocity of light ($v = \frac{4}{5}c$). The third man, Harry, will remain on earth and attempt to communicate with each traveler by means of UHF transmissions. Although all three radio operators will transmit on the same frequency, they will receive on different frequencies due to their unequal motions (Doppler Effect). Tom and Dick agree to transmit brief daily messages to Harry who will reciprocate by sending brief daily reports to Tom and Dick. Before take-off the three men synchronize their clocks. To avoid undue complications in the recording of the travelers' clock times, we will make the reasonable assumption that the periods of acceleration at the beginning of the outward and return paths and the periods of deceleration on approaching the star or the earth are exteremely brief in comparison with the length of time spent in moving at constant velocity. We can predict from relativity theory, employing the time dilation factor, that Tom will be gone for 40 years and Dick for 30 years according to Harry's clocktime. However, Tom will claim that he has been away for 32 years by his clocktime while Dick will assert he has been gone for only 18 years by his clocktime. To clarify these conclusions, consider Tom's situation. It takes a light ray 24 years to make the round trip between the earth and star, S. Tom, traveling at 3/5 the speed of light, will accomplish the feat in $\frac{24}{3/5} = 40$ years judged by Harry's clock. But since Tom's clock runs slow by the factor $\sqrt{1 - \left[\frac{3}{5}\right]^2} = 4/5$, Tom's round-trip time will be $4/5 \times 40 = 32$ years according to Tom's clock.

Let us now consider the rate at which Harry's daily messages will be received by Tom and Dick in their rocket ships. It will not be once per day! Relativity theory informs us that the receipt of information transmitted from earth at a constant repetitious rate by either light or radio signals by an observer rapidly receding or approaching the earth is dependent on the frequency or rate with which the signal is being transmitted, on the Doppler Effect, and on the time dilation factor. Although the formulae expressing these relations can be understood by anyone who has had at least one year of algebra, the reader will be spared the inconvenience of verifying the calculations and the conclusions will be simply stated. This is what will happen.



Employing the data; distance = 12 LY, $v = \frac{3}{5}c$ for Tom and $v = \frac{4}{5}c$ for Dick, and the signal rate one brief message per day,) one obtains the following results: Harry will be transmitting daily messages to Tom going out and coming back on frequency, f_o, for 40 years and to Dick on the same frequency out and back for 30 years as measured in Harry's time. During the outward portion of the trip, Tom will receive Harry's daily messages every other day on one-half the operation frequency, $\frac{1}{2}f_o$, for 16 years and on the way back twice daily at double the operating frequency, $2f_o$, for 16 years according to Tom's time. Dick will receive Harry's daily messages once every third day on one-third the transmitting frequency, $\frac{1}{3}f_o$, on the way out for 9 years, and on the return journey three times per day at triple the transmitting frequency, $3f_o$, for 9 years according to Dick's time. Note the slower outward rate of the received messages and the lower, shifted frequency of the reception of Harry's signals by both Tom and Dick as they rapidly recede from the earth and the faster return message rate and the higher, shifted frequency of the reception

of Harry's signals by Tom and Dick as they rapidly approach the earth. The preceding results are the natural effects of the relativistic Doppler Effect and the time dilation effect becoming important at high speeds. This is easily confirmed by referring to expression (2) and dividing it by the contraction factor, $\sqrt{1 - \frac{v^2}{c^2}}$, to allow for the slower rate of the travelers' clocks. For example, in Tom's case, when he is moving away from the earth, he will receive Harry who is transmitting on the frequency, f_o, on a lower frequency $= f_o \frac{(1 + 3/5)}{\sqrt{1 - (3/5)^2}} = 2f_o$.

The same ratio, $\frac{1}{2}$ or 2, also holds for the rate at which Tom receives Harry's brief daily messages which may be likened to signal flashes of radio or light bursts occuring once each day on earth.

What about Harry's receipt of messages from Tom and Dick both of whom agreed to transmit brief daily reports to him on frequency, f_o, during their respective round-trip journey to star S and star T? It should be observed that Harry will receive Tom's and Dick's daily transmitted messages at the slow rate during most of the time. In other words, the outgoing slower rate of received messages on earth from Tom and Dick covers a longer interval of time for Harry than the incoming faster message rate because there is a time lapse of 12 years before the last of the outgoing transmitted signals reach the earth traveling over the distance of 12 light years after the rocket ship has turned around and is headed back to earth and by the time the new received faster signal rate reaches the earth, the ship is well on its way toward the earth. The record of Harry's communications log is startling but nevertheless true; as will now be shown.

Harry will receive Tom's daily reports on one-half the transmitting frequency, $\frac{1}{2}f_0$, every other day during Tom's outward journey and the first part of the return trip for $20 + 12 = 32$ years and during the remainder of Tom's return trip on double the frequency, $2f_0$, twice daily for $20 - 12 = 8$ years as measured in Harry's time. On the other hand, Harry will receive Dick's daily reports during Dick's outward trip and most of the return trip on one-third the operating frequency, $\frac{1}{3}f_o$, every third day for $15 + 12 = 27$ years and on triple the transmitting frequency, $3f_0$, three times per day during the remainder of Dick's return voyage for only $15 - 12 = 3$ years according to Harry's time. The total number of messages received by Harry is the same going out and coming back.

Suppose all three radiomen are 20 years old at the time the journeys begin. Dick will return to earth first and find that Harry is now 50 years old while he is only 38 years old. When Tom comes back to earth, he will fiind that Harry is 60 years old while he is 52 years old. When Tom and Dick meet again on earth, Tom will be only 4 years older than Dick because Dick returned sooner than Tom by 10 earth years. By this time the reader must be aware that to stay eternally young he should travel with the speed of a lightning bolt but he will never be able to communicate with his fellow man on earth because his received Doppler-shifted frequency will be either zero or infinity.

. . . K6BW

Surprise in the Skies

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What are pulsars? Radio astronomers and other scientists all over the world are trying to work out the unexpected mystery posed by four sets of strangely regular, short, sharply pulsed radio signals from space. Several months of effort have resulted in an impressive number of contributions to the scientific literature, but the possible sources suggested so far have not successfully accounted for the signals actually observed. At this writing (July 3, 1968) it appears nobody knows what pulsars are, and new measurements, just published, will probably obsolete much careful thinking. Hardly tongue-in-cheek, I suggest "posers" might be a better title for the sources of these remarkable signals from space.

Although pulsar signals are very powerful at their point of origin, their distance of many tens or a few hundreds of lightyears attenuates the signals so that a good receiving system is needed to hear them. F. S. Harris (Is that *Sam* Harris?) has heard them at Aricebo Observatory in Puerto Rico using a 50-foot paraboloidal reflector on 144 MHz. From this it appears any ham who can try moonbounce work might be able to hear pulsars. This raises an interesting thought.

Why couldn't pulsars have been discovered by an amateur operator? Too bad they weren't. It would have done a lot for ham radio. Well, to find out something about pulsars let's start with a few notes on radio astronomy.

Radio astronomy

Radio astronomy originated before WW2 as an amateur electronics hobby rather than an amateur radio hobby. But it did not become a recognized scientific field until after WW2, when scientists using the radar and radio techniques developed for military applications, began to point their antennas out toward space to find out what they could hear.

It turned out they could hear a lot, and soon they were busy mapping the sky for radio brightness. Investigations in this field began to answer questions about our sun's location in space, and provided information about the shape of our galaxy and the distance to its center. Radio astronomy complemented optical astronomy very well since radio signals could penetrate the huge dust clouds found in many parts of the sky and particularly toward the galactic center.

Just as the optical telescope is one of the prime tools of the optical astronomer, the radio astronomer works with a radio telescope. But a radio telescope is simply a very large radio antenna with strongly directional characteristics, rather than an array of lenses and mirrors. A very good radio receiver completes the research installation, which may be very simple.

I was surprised to discover there are a number of amateur radio astronomers in England. I haven't come across any mention of American amateur radio astronomers, but I think this special form of engineering electronics might be interesting to hams who would like to try some new ideas.

As the radio astronomy field developed it became important in its own right. Workers found many surprises including radio stars which could be observed by radio but were invisible to any optical system. Some other stars were found which were visible both by radio and light observation, and one of these is the very interesting Crab Nebula, a remarkable sight centered on a star believed to have exploded into a supernova in our year 1054 AD. Other radio observations were made at various distances ranging from the planet Jupiter, right in our own backyard as such things go, out to several times the range of the visible universe.

Later, astronomers discovered the enigmatic sources called quasars, whose nature and distances are still uncertain. Opinions as to the nature of quasars have ranged from primitive galaxies in a very early stage of development to a radical suggestion they might be huge spaceships traveling in our own galaxy at relativistic speeds. Some observed facts suggest quasars are right here

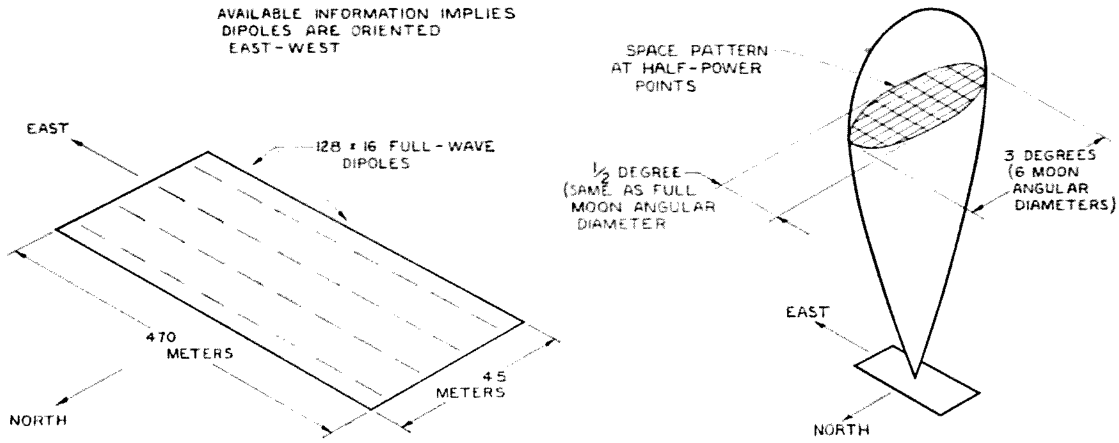

Fig. 1. The antenna system at Cambridge, just completed, which located the only four known pulsars. Electrical switching can sweep the beam lobe N-S and E-W across the sky.

in our own galaxy but the weight of the evidence indicates they are very far out and may be some of the most distant objects observable by both optical and radio means.

As the radio astronomers have built more effective radio telescopes they have continued to find interesting new facts, challenges, and problems. Radio astronomy has provided much useful information for cosmologists thinking about the nature and age of our universe. Some quiet, steady and nearly undetectable radio noise that comes in equally from all directions appears to be the still-echoing whisper remaining from the furious thunder of creation an estimated 26 billion years ago. This observation has received some attention over several years but it is not regarded as a very important matter.

While I was researching this article I came across a very interesting letter published by one radio astronomer who thinks a recent radio survey may have seen halfway around the universe. Some extremely faint, distant radio objects observed in a certain direction just might be, he suggests, the same ones we discover by looking in the opposite direction. He supplied a list of five prime possibilities and another five less likely candidates. If this is correct then we have some very useful information for testing theoretical investigations into the age and size of the universe.

Pulsars

One requirement for the continued develpement of radio astronomy has been better antennas and receivers. Another has been improvements in methods of detecting weak signals, and some of this work has appeared in the amateur radio field in moonbounce and space communications work. In a remarkable boundary-jumping effect, one valuable radio astronomy result has been the development of improved methods for studying human brain function. This has some very important and useful medical applications.

It was a natural development in 1967 for Cambridge University, in England, to be building a new and better radio telescope. The new instrument's antenna consists of a 128 x 16 planar array of full-wave dipoles with tiltable plane reflectors. The system's long axis extends in an east-west direction as shown in **Fig. 1.**

This system was designed to operate at about 81.5 MHz. Its beam direction is changed by switching in time delays from different sets of elements, so that without moving the antenna its lobe can be pointed at different parts of the sky. The antenna can be used with up to four receivers simultaneously to look in four different directions, a mass-production arrangement appropriate for achieving the maximum use from a rather expensive installation.

The new radio telescope was finally put into operation in July, 1967. Its operators started making regular routine sky surveys, a simple business of mapping the sky's radio brightness time and time again, looking for changes, and anything unusual, of interest. They observed some sporadic interference of unknown source and finally, in November of 1967, they started looking for the cause.

An answer appeared shortly. The appar-

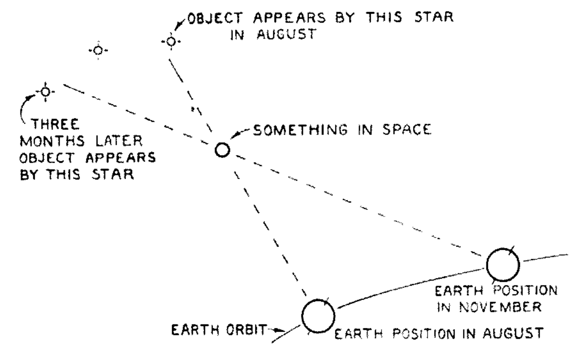

Fig. 2. Why the radio sources would seem to move in the sky if they were relatively close to the earth. This is the same geometry that causes parallax in reading instrument scales.

ent interference was a steady stream of pulsed signals coming in from space. An investigation of past records and some additional tests showed the astronomers that they had discovered four strange radio sources in space, generating signals unlike anything known to come from any previously studied sources.

It was reasonable to suppose these signals resulted from some unannounced space-research activity. A space probe? *Four* space probes? Unlikely, and it could not be some reflection from the moon or some other body, of radiation originating on the earth, because the sources of the signals did not seem to move about in the sky as the earth moved through space.

See **Fig. 2.** If the source were nearby, the earth's orbital motion in space would cause a nearby object to move across the sky relative to the stars. After reviewing their records and doing careful additional research, the astronomers concluded their newly discovered signals had to be coming from some unknown source too far away to have any connection with human activities. Finally, on Feb. 24, 1968, their results were published under the unobtrusive title "Observation of a rapidly pulsating radio source." I've listed it in the Bibliography.

That paper has undoubtedly upset a number of carefully planned research efforts. Starting from zero, there have been at least 35 additional papers published since, which probably sets some kind of a scientific record. The great observatory at Jodrell Bank promptly turned its 250 foot diameter paraboloidal reflector towards the signal sources and provided additional verification at frequencies other than 81.5 MHz. And a furious effort at Aricebo Observatory in Puerto Rico produced no results at first, but after its operators installed a new Sears-Roebuck TV antenna at the focus of the great 1000-foot bowl the signals were observed very strongly there. In a couple of months the strange signals had been named "pulsars," an abbreviation of "pulsating radio stars," and they had made the front pages of some large newspapers.

There was some thinking that such sharp, regular, unlikely signals must originate in some intelligent purpose, and newspaper reports suggested the matter was all but settled. More sober thoughts have prevailed, though, since compelling facts indicate that like all the other signals observed so far from distant space, these have some natural origin. What is that origin? There are many suggestions but nobody knows.

The picture—so far

I've heard tape recordings of pulsar signals, and they certainly sound like something originated by life. They are a steady, regular rasping beat that sounds more sensible than the jamming transmitters and other signals that may be heard on shortwave receivers. The pulses give a tremendous impression of power, stability, and intelligent purpose. They sounded to my ear as if there *must* be somebody out there deliberately triggering them off. It is easy—too easy, to believe that if we are smart enough we can work out who it is and what they are trying to do.

The work on pulsars has been so intensive a recent report in Scientific American magazine appeared under the title "The Pulsar Industry." Pulsars seem to be the number one order of business for many scientists all around the world, and their work as described so far has tended to fall into three general classes.

First, the astronomers have tried to obtain better recordings and measurements of the pulsar signals. They have been making very careful records of timing, signal strength, and the varying polarization of the incoming radio signals. These are rather hard to hear because they are weak, and the best equipment possible is required. Many observational reports have appeared, providing new facts useful to workers thinking about what kind of sources could be generating the pulsar signals.

The second area is theory research, in which workers thinking about possible

sources try to work out what these sources should sound like if they operate according to familiar rules already understood. This work is a continual process of developing possible models, calculating the consequences, and seeing how well the results square with observations. So far as pulsars are concerned the work has not been very successful in finding an answer although a wide variety of interesting proposals have been studied.

And finally, some researchers are trying to obtain new information by discovering light signals from the pulsars. If the pulsars emit radio flashes, the reasoning goes, perhaps they emit light flashes also, and if we can identify which star is doing the flashing maybe it will turn out to be a kind of star we already know something about.

Results so far indicate pretty definitely that all four pulsars are the same kind of radio event, with some individual variations. All four have similar pulses with a similar 12-millisecond time schedule in the pulse structure except for one whose pulse is similar to the first part of the more complex pulse emitted by the other three pulsars.

The first pulsar discovered was CP1919. It is slightly the strongest, and it has received the most scientific attention. This is the pulsar F. S. Harris has observed at Aricebo using a 50-foot paraboloidal reflector. Its power level is sometimes as great as 200 x 10^{-26} watts per square meter per Hz peak, and its signal is a three-part pulse about 36 milliseconds long. This is a model pulsar pulse, consisting of parts A, B, and C in **Fig. 3.** Its period is about 1.337 seconds, and its amplitude shows wide variations which are believed to originate in the source rather than propagation effects.

This is the pulsar that was investigated in a search for optical flashes. At least three observatories performed tests. A European observatory tried a rocking camera arrangement timed to the pulsar signals so that a flashing star would leave a distinctive image different from the steadily shining stars in the area believed to contain the pulsar. This test was not successful, and attempts were made in America using elaborate cooled-photocell and computerlike analysis systems. These were not successful either. Although reports of success have appeared in the papers and were circulated at the Pulsar Conference in N.Y.C. at the

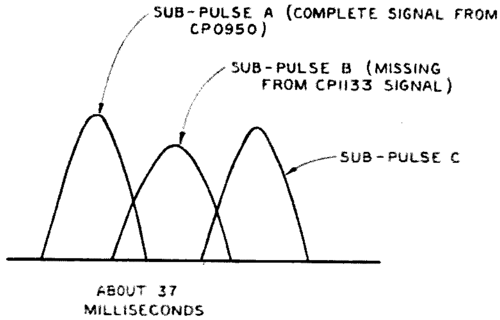

*Fig. 3. **All Four pulsars generate signals that are some variation on this scheme. And they all have the same timing.***

end of May, so far nothing has been sighted in the sky that could be identified as a pulsar.

The latest research reports, just out at this writing, indicate the pulsar signals are more complex than shown in **Fig. 3.** New work with a faster system at Aricebo have shown the pulse shapes of **Fig. 3** are only average results. The pulses are really composed of many spiky microsecond pulses of much greater amplitude. The tough problem of pulsar signal sources has just become a bit tougher. But amateur radio gear is likely to see the signals as they are described here.

Pulsar CP1133 has a peak power level similar to that of CP1919 but a period of 1.188 seconds. It emits a doublet pulse consisting of a normal initial pulse, followed after a 12 millisecond delay by a normal terminal pulse. Look again at **Fig. 3,** this is sub-pulses A and C. The central pulse is usually missing but has been observed occasionally.

Pulsars CP0834 and CP0950 are considerably weaker, with peak powers at reception of around 60 x 10^{-26} watts per square meter per Hz. CP0834 pulses once per 1.274 seconds with a pulse shape similar to that of CP1919, and CP0950 pulses once per 0.253 seconds with a short single pulse similar to sub-pulse A of **Fig. 3,** about 20 milliseconds long. Perhaps at its relatively short period it just doesn't have time to carry out the complete sequence. It just is not believable that a sunlike object should emit almost four sharp, distinct pulses per second —until you actually hear it.

Pulsars present a real scientific problem that is likely to be important in the future. It is a tough problem, too, but the response to this challenge has been very strong. My guess is that the questions will be worked

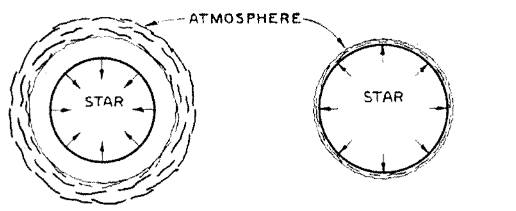

Fig. 4. A Sufficiently massive oscillating star could collapse inwards leaving a gas shell behind, and then expand outwards again striking the shell. Resulting pressures and ionization would generate radio signals.

out within a year or so, and here are some of the many possible sources astronomers are working on now.

Pulsars could be white dwarf stars or neutron stars, oscillating radially with periods equal to those of the observed radio signals. Some previously worked out computations seemed to indicate white dwarf stars could not oscillate fast enough, and neutron stars would oscillate too rapidly, to cause the pulses actually measured. These objections have been countered with new calculations and suggestions about possible overtone vibrations. See **Fig. 4.**

Another possibility is that two neutron stars are orbiting very rapidly around each other. The atmosphere and gravity fields of each star in turn could serve as a lens to focus the other star's radiation in our direction for a brief interval when the stars were on a direct line toward our sun. This mechanism has been written off because it would generate pulses with cyclic differences that have not been observed.

Certain events known in our solar system generate signals having some characteristics of pulsar signals. Our planet Jupiter emits radio bursts apparently timed to the orbiting of its sattellite Io, but a recent scientific paper concludes any satellite orbiting a star fast enough to trigger the observed signals could not exist. Too many contradictory requirements. There does not seem to be any work out that attempts to relate pulsar signals directly to events observed on our sun but a possible similarity has been suggested.

A key observation is the pulsar signals' steady rate. The time stability of the signals compares very favorably with the best atomic clocks anybody has been able to build. This suggests the pulsar signals must be triggered off somehow by a huge, massive rotating body.

The possibility it is an ordinary star have been ruled out. Theoretical astronomers have been thinking for several years about what happens to stars after they have exploded—and stars do explode sometimes, violently. The explosion is called a nova, or if it is a really large one, a supernova. After the explosion, according to calculations, much of the star's material will remain but its nuclear fuel will be nearly exhausted and the star cannot maintain its original size. It collapses inward, and a mass substantially greater than that of our sun may be packed into an intensely hot, rapidly rotating body a *few miles* in diameter. It becomes a white dwarf star (a few of these have been observed) or a neutron star. Present thinking tends to the idea that when pulsars are understood there will be some direct connection with an old nova, probably collapsed into a neutron star.

Can we hear pulsars?

I don't really know. I worked out some figures that indicated Aricebo couldn't hear them. Obviously there was an error in there somewhere, and I think it is in the receiver department. Nothing appears in any of the scientific reports as to how good the radio astronomers' receivers really are, but evidently they are considerably better than the usual engineering equations assume.

Since F. S. Harris heard CP1919 with a 50-foot reflector, it appears pulsar signals are in the moonbounce range of difficulty. I worked out his antenna gain must have been around 22 db and probably not over 26 db. There are many moonbounce antennas built offering higher gains than that. One in Australia, described in the July issue of 73 Magazine on page 66, is rated at 34 db gain, but it is a huge double rhombic and probably cannot be pointed at any pulsars.

Some ham ought to be able to hear pulsars, I think. I hope he tries.

. . . W1EZT

Bibliography

If you're interested in more detail on pulsars you probably can find it in a nearby library. The librarian will be glad to help you out and can obtain books and magazines for you in a few days from other libraries

if they are not on the shelf. Here is what you look for, and you can find the rest of the 36 papers so far by using bibliographies at the ends of the papers, and looking in other copies of the magazines.

1. Craft et al: Submillisecond radio intensity variations in pulsars. Nature *218* 1122 (June 22, 1968). This is the latest at the time of writing.

2. Davies et al: Pulsating radio source at 19H 19M, +22°. Nature *217* 910 (Mar. 9, 1968). The first report from Jodrell Bank. It arrived in Nature's editorial offices seven days after Hewish's paper was published. Probably a near record.

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Using Thin-Wire Antennas

A thin-wire antenna can often provide an antenna "solution" in situations — either permanent or portable — where an obvious antenna is not desired. Various special considerations to observe when using thin-wire antennas are explored.

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Many amateurs who live in apartment houses, or even in private homes, are faced with the situation that a conspicuous outside antenna cannot be erected. One solution to this problem is to use an indoor antenna and accept the signal loss caused by absorption due to the building structure. Such antennas can be reasonably useful depending upon specific circumstances—height, building construction, etc. They also can cause tremendous problems, such as coupling *rf* into power lines and other wiring circuits. Working on the basis that almost any type antenna placed outdoors will work better than an indoor type, one is faced with the problem of constructing a reasonably inconspicuous antenna. No antenna can probably be completely inconspicuous to someone who knows what to look for, but at least the average person will regard any piece of wire that is visually inconspicuous as being inconsequential both from an aesthetic and interference viewpoint. Many approaches may be tried to produce an inconspicuous antenna, but probably the simplest and least expensive uses extremely thin wire in lieu of conventional large antenna wire.

This article explores various considerations which one should observe when constructing a thin-wire antenna in order to obtain the most efficient performance.*

* what constitutes 'thin-wire" or a reasonably inconspicuous size depends upon specific circumstances, but generally a wire size of AWG #18 or smaller is meant.

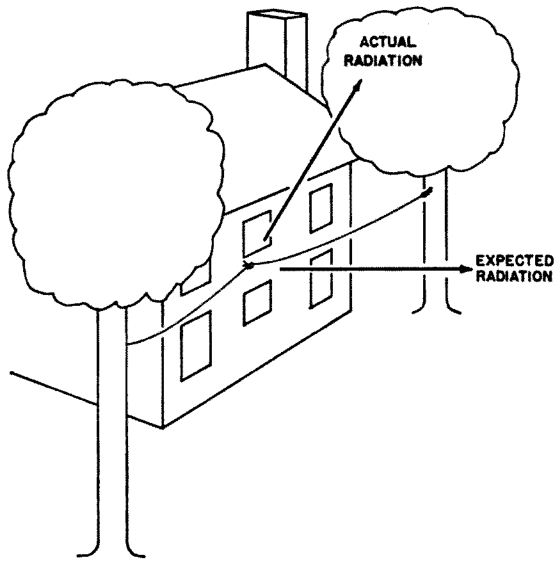

Fig. 1. As explained in the text, depending upon which ground surface has the major effect, the radiation from the antenna may not be as shown but actually up and down. Reorientation of the antenna may produce considerably more effective radiation.

Antenna Type and Placement

As will be explained more fully later, thin-wire antennas, because of their very nature, can develop very high voltage points with even only moderate transmitter power. Therefore, one of the great problems which may develop with such antennas, is *rf* in the shack when a single wire type is used with a ground connection to a plumbing or heating system. An unbalanced antenna should be avoided if at all possible and some form of balanced antenna used—a dipole or V—even if it means that each leg of the antenna will be shorter than that obtainable with a single long wire. A transmission line should be avoided if possible, and both legs of the antenna coupled directly to the

terminals of an antenna coupler located near a window or on a balcony. If a transmission line is used because a considerable height advantage can be achieved by remote location of the antenna, one is faced with the conflict that the less conspicuous the transmission line, the greater its attenuation. A generally acceptable compromise is to use 72 ohm receiving twinlead, which is relatively small and has acceptable losses if runs of 50 feet or less are used. Another possibility for a really small coaxial transmission line is RG174 A/U, which is a 50 ohm cable only 1/10 in diameter. Again, its losses are tolerable only in runs of about 50 feet and its power handling capability is no more than 50 watts.

The placement of the antenna should avoid coupling to surrounding lossy surfaces. The worst condition probably exists when an antenna is run close to and parallel to a building surface. Ideally, the antenna should be placed at right angles to the building surface, or if parallel to it, at least as far away as is consistent with keeping the installation inconspicuous. There is certainly more art than science involved in the placement of such antennas in a complex building structure, but the above two rules seem to consistently apply.

Antenna directivity is another factor which defies any exact rule-making. Normal dipole radiation is, of course, at right angles to the line of the antenna. But, when the antenna is extremely close to a ground surface, considerable low-angle radiation in line with the antenna may occur.

Another problem is in determining what the ground surface is for an antenna. When it is mounted away from a building wall of considerable area in terms of wavelengths, the building wall may form the ground surface for the antenna, rather than the earth surface. For instance, in **Fig. 1**, if one considered the earth surface as the ground surface, radiation should be expected in the direction shown by the arrow. However, the building surface may well act as the ground surface and one may simply be radiating most of the signal straight up and down. The solution, of course, would be to rotate the line of the antenna by 90 degrees, so that the radiation is bi-directional with the building surface acting as the ground surface. This rather simple re-orientation of an antenna can produce a very dramatic

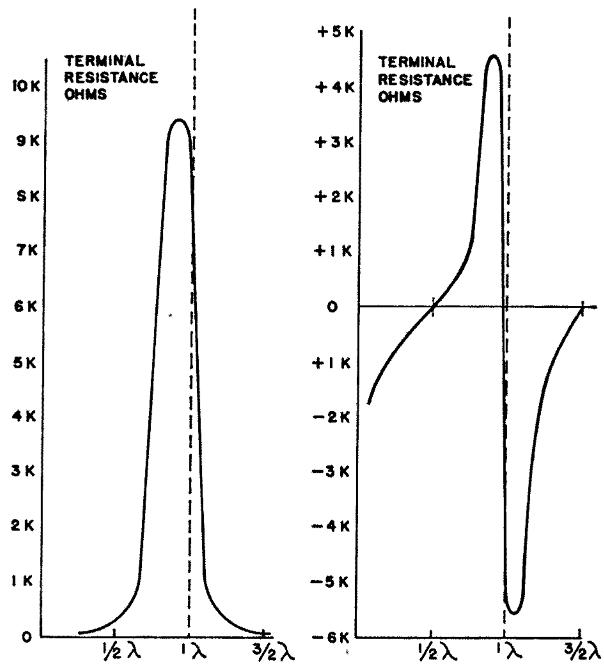

Fig. 2. Free-space resistance and reactance values for a dipole having a wire diameter of λ/100,000 (approximately AWG #26 wire used on 40 meters). Of interest is the fact that when the dipole is an even multiple of a wavelength long (physically), resonance as defined by zero reactance actually occurs at a slightly shorter length. The curves basically repeat for longer length antennas except that the peak amplitudes slowly decrease.

improvement in performance in many apartment situations.

Antenna Impedance and Coupling Methods

Fig. 2 shows the resistive and reactive terminal values of a dipole antenna as its length varies between essentially 0 and 1½ wavelengths long overall. The curves are shown for an antenna having a wire diameter of λ/100,000, or about AWG #26 wire used on 40 meters—which certainly qualifies as a thin-wire antenna. With slight modification, the resistive and reactive values repeat as the antenna is made longer in terms of wavelength.

The values shown are based upon a dipole in free-space and although it is not desired to make a complex subject even more involved, it should be realized that proximity to a ground surface will modify the values shown, particularly the resistive component. The reactance of a ½ wave dipole in open space, as read from the graphs, would be zero, and the resistance about 70 ohms. As the antenna is placed nearer a ground sur-

face, however, particularly below 1/10 wave distance, the resistance decreases rapidly and can easily be only a few ohms, as for a 40 meter dipole placed a foot above a ground surface. This is one of the reasons why the use of a transmission line to feed a remotely located dipole is generally not recommended unless the height advantage gained thereby is very considerable. Without appropriate instrumentation, it is difficult to determine the input impedance of a dipole remotely located close to a building surface and one will likely end up with a transmission line operating at a very high SWR.

It should also be noted from **Fig. 2** that the swings of the resistive and reactive components of the dipole are particularly dramatic when the overall antenna length is an even multiple of a wavelength. Therefore, if one had an antenna which was being used on several bands so that on various bands its length was an even multiple of a wavelength, major readjustments of an antenna coupler might be required for minor frequency excursions within a band in order to resonate the antenna system. Because of this consideration, as well as other factors discussed next, it would be better to choose a length for a multi-band antenna so that the terminal impedance remains within reasonable limits on all bands. For instance, if one chooses an antenna length of ⅜ or ⅝ wave on the lowest frequency band to be used, the impedance values on higher frequency harmonically related bands should be well within the range covered by a simple transmatch type antenna coupler. If a basic length of ¼ or ½ wave were chosen, however, it is unlikely that a transmatch coupler could accommodate the impedance range of various harmonic frequencies.

Voltage and Current Considerations

Besides the problem of choosing an antenna length which a conventional coupler can handle, there are also insulation and wire size considerations which affect both the antenna and the coupler. If one operated a basic ½ wave antenna on its second harmonic, the terminal impedance would be from 7 to 9 K ohms, as shown in **Fig. 2.** With a 100 watt transmitter this would produce over 700 volts of *rf*, and over 1600 volts of *rf* with a 300 watt output transmitter. The voltage distribution on such an antenna would be as shown in

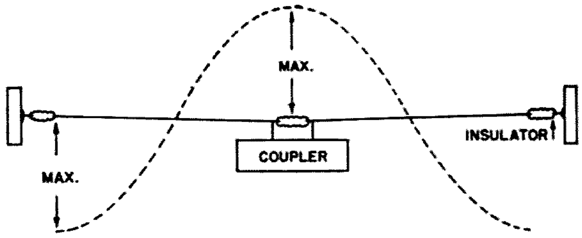

Fig. 3. Voltage distribution along a ½λ dipole operated on its second harmonic.

Fig. 3. The voltage peaks occur at the dipole terminals and at the far ends. Thus, the components within the antenna coupler, the feedthrough insulators connecting the antenna to the coupler, and the end insulators all have to be rated for a relatively high voltage if arc-overs (within the coupler) and losses due to long leakage paths are to be avoided.

The consideration that must be given to the effects of current flow can be seen if a ½ wave dipole is considered operating on its fundamental with a terminal impedance of 50-70 ohms. At the terminals a 100 watt transmitter (CW) will produce about 1.2 amperes. A 300 watt transmitter can produce almost 2.5 amperes. Obviously, very small wire sizes will not handle such currents although in reality one can get away with using thin wires far beyond their "handbook" current rating because of the intermittent nature of most transmission modes. Nonetheless, AWG #22 wire cannot handle more than 1 to 1.5 amperes and AWG #18 about 2.5 amperes. When one considers really thin wire—down to AWG #30 sizes—the current ratings go down to a few hundred milliamperes.

All the possibilities which involve voltage and current maximums in harmonically operated dipoles can become quite complex. But the above simple examples demonstrate another disadvantage of constructing multiple half wave antennas of very thin-wire. If the antenna is constructed to avoid operation on ½ wave multiples, the terminal impedance will not vary over such wide excursions. The voltage and current maximums will be less and both insulation requirements and wire size requirements will be reduced. The reactive component of the dipole impedance produced by such operation can be easily tuned out with a conventional antenna coupler.

Wire Selection

A wide variety of wire types is available for construction of a thin-wire antenna. Exactly which type one should use depends upon a specific installation—the length of the antenna, the tension that will be placed on the wire, and how far one wants to go to be inconspicuous while still retaining a wire size adequate to handle the transmitter power. Insulated magnet wire, made of tinned copper, is available in sizes down to AWG #40. One should use the type with a double polyester film coating, but, even then, the smaller sizes will stretch considerably with only slight tension. So-called indoor antenna wire (Belden 8014) is the stranded equivalent of AWG #25, but has considerably better tensile strength. Boinbach high-temperature miniature wire (7524-7534 series) is available in AWG 24-34 sizes and is similar to magnet wire except that it is available with a variety of colored thermoplastic films—in case one really wants to make an effort to have the antenna blend with a background color.

The smallest size in which 40% copperweld wire is available is AWG #18 (Saxton 5300). It is the best choice if such a size is acceptable. Piano wire is available in smaller sizes, but may corrode in certain environments. Its springiness also can make it difficult to handle. Clear plastic fishing line functions nicely as a combination insulator and tie line for the antenna ends.

Summary

Thin-wire antennas can perform very well when properly installed, and can provide an antenna solution in situations where a conventional installation cannot be used. The considerations involved in using a thin-wire antenna successfully differ somewhat from those when using conventional antenna construction and this article has tried to highlight the main considerations to watch.

In summary, a balanced form of antenna should be used, if at all possible, which is directly coupled to an antenna tuner. The antenna length should be chosen to avoid impedance extremes on harmonic operation and a high current loop at the tuner terminals on fundamental operation. A tuner should be used which can properly couple to a balanced form of antenna—a transmatch tuner, for instance, and not a pi-network tuner. . . . W2EEY/1

7 MHz Transistor Transmitter

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In a number of years of hamming on a relatively mild scale, the author has never contacted another station who, at the moment, was running transistorized homebuilt gear. This seems odd indeed, especially in view of the fine transistors available today at reasonable cost and indicates that the activity is not as great as it might be.

Some experimentally inclined hams may have shied away from transistorized transmitters because they are frequently multistage affairs requiring specialized equipment and techniques for tuning. This article is directed particularly to those who may want to jump in and get their feet wet for the first time.

By way of background, a transmitter circuit similar to that used here was first tried in the spring of 1960 with excellent results. The transistors used were a pair of RCA 2N247 drift transistors with inputs limited to a hundred milliwatts or so. This was fine for a short while when the spirit that years ago speculated, "what is the ultimate power input a 6L6 will take", again prevailed, and before long the little rig was running at more than a watt input. To prevent the breakdown in the transistors, which occurred if the key was held down more than a second or two, from being catastrophic, four #47 pilot bulbs in series with the 22½ volt collector supply were used. This power limiting device allowed several trips into the breakdown region before the transistors lost their desirable characteristics. Later drift transistors of the 2N640 type proved a little more rugged and several survivors were used in this project.

The transceiver (actually transmitter-receiver) presented here consists of an 8 to 10 watt input crystal controlled transmitter link coupled through a send-receive switch to the antenna. A device is included to protect the *rf* transistors from burnout. The receiver follows traditional *trf* design with an *rf* amplifier and reflex regenerative detector followed by two stages of audio amplification. A keying monitor and spotting oscillator are included as operating conveniences. The transceiver went through several variations in the course of its evolution. A speaker driven by a class "B" audio amplifier was originally incorporated. The fluctuating current drain of this stage caused instability in the note of the received signal and was abandoned in favor of single-ended class "A" stage driving a headset. The speaker was never missed, however, since CW operation and the use of headsets is somehow synonymous. The first three stages of the receiver were enclosed in a separate shielded box with the idea that the transmitter could be monitored directly. The shielding proved inadequate and the keying monitor and spotting oscillator were added as a substitute. If the job were to be done again, the shield box would be eliminated entirely with the *rf* stage located under the chassis next to the send-receive switch with the balance of the receiver above the chassis.

One of the cheapest and most convenient sources for powering portable transmitters of this power level are any of the large 45 V "B" batteries such as the Burgess 21308SC or the RCA VS 127W or VS 157W series. They are capable of normal 300 mA discharge rates and one of these will furnish a whole summer of trouble-free operation at a cost of about $6.00 to $7.00. These types may not be readily available on the dealer's shelf as the demand seems to be low, but this is really a break in your favor since the one you order is much more likely to be fresh.

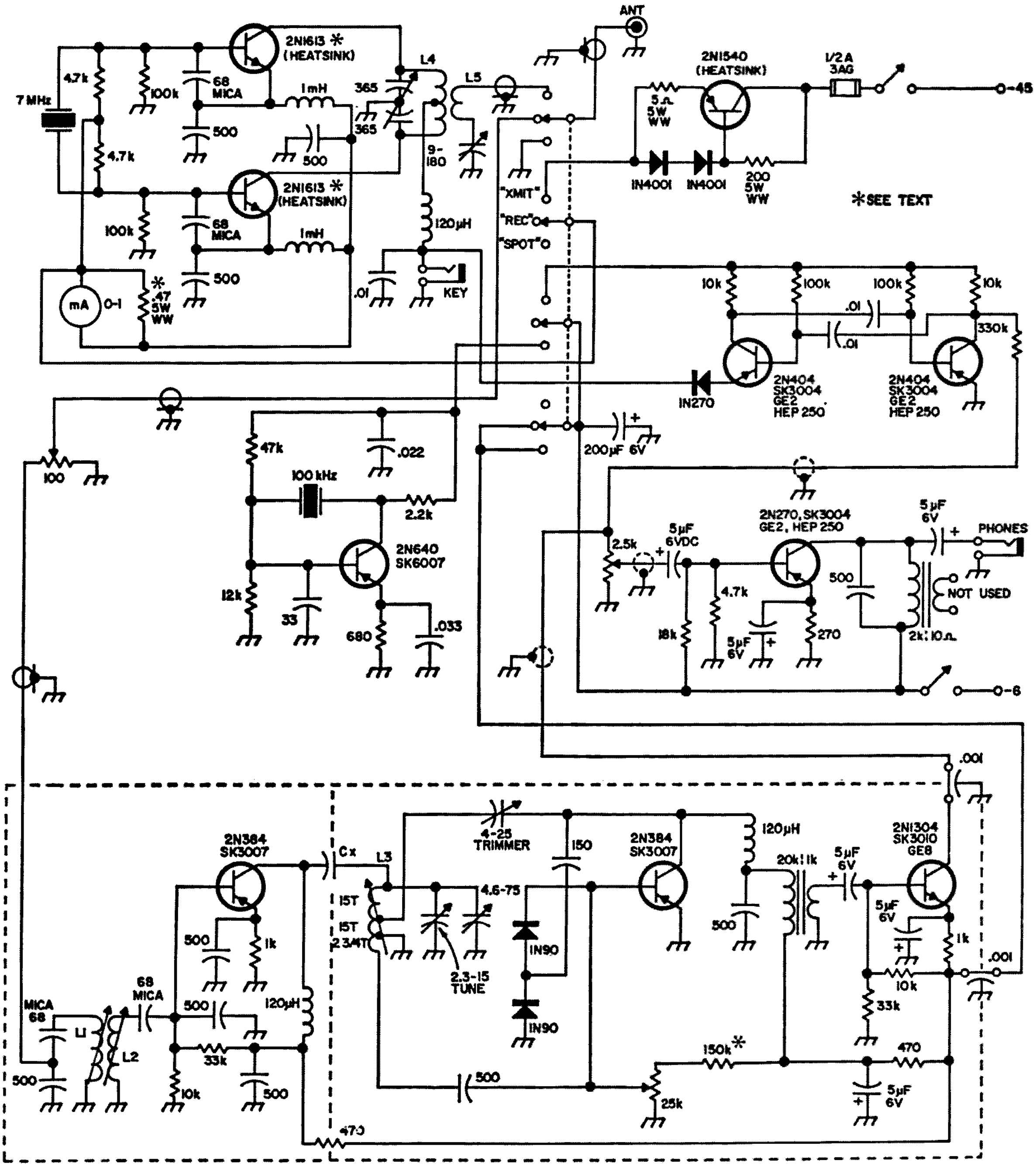

Fig. 1.

L1, L2 30 *turns* #32 *enameled wire close wound on* ¼" *slug tuned form. J. W. Miller* 46*A*000*CPC or CTC* 2206-2-3

L3 32¾ *turns* #32 *enameled wire close wound on* ¼" *slug tuned form. (same form as above)*

L4 11 *turns* 1" *diameter* 16 *TPI. AirDux or B & W.*

L5 4 *turns hookup wire wound around the center of L4.*

Receiver

The first three stages of the receiver are built on perforated vector board with ⅛-inch pitch holes mounted inside a small LMB "Jiffy Box". An aluminum barrier is mounted on the vector board on both sides to shield the *rf* stage from the Detector stage.

RF Stage

The antenna in receive position comes through the "receive-transmit-spot" function switch to R-10 which is the *rf* gain control.

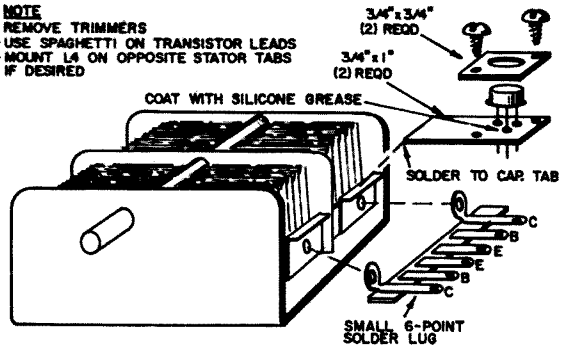

Fig. 2. Details of the heat sink.

L-1 and L-2 terminals fit the hole pattern of the board and result in a coil spacing of ½-inch which seems adequate. The two resonant circuits form an elementary bandpass filter that does not require tuning to cover the 200 kHz of the CW portion of the 40 meter band. The *rf* amplifier is straightforward and no attempt is made to adjust the gain of this stage because changing the parameters of the transistor would result in some pulling of the detector. Cx is a 1 pF capacitor but a gimmick consisting of several twists of hookup wire would be even better in that it would be adjustable.

Detector

The detector tuned circuit, consisting of L-3, C-8 and C-9, will give a tuning range just covering the CW portion of the band. The dial assembly is a National Velvet Vernier removed from a BC-375 tuning unit and equipped with a plastic pointer. The Reflex regenerative detector functions as follows: *RF* signals in the tank circuit are coupled through C-7 to the base of the transistor. Resistors R-4 and R-11 provide an adjustable bias network for the transistor and functions as the panel regeneration control. The *rf* signal is amplified by the transistor and is fed to the voltage doubling detector C-11, D-2 and D-1, C-7 and reflexed back into the same base as an audio signal. RFC-2, C-12 isolates the rf signal and couples the amplified audio signal through T-1 to the following stage. Resistor R-4 may have to be altered to give a proper range of adjustment to the regeneration control and an operating point whereby the bias adjustment versus feedback settings of C-10 will be found that is optimum for any particular transistor used.

Audio Stages

The audio stages are straightforward and if the prospective builder does not require high output levels, the headset could be coupled to the first audio amplifier in place of the Volume control, R-12.

Monitor

A keying monitor, consisting of Q 5 and Q 6 connected as a free running multivibrator, is incorporated. Values of C-29, 30 and R-30, 31 were chosen to produce a pleasing note. The output is coupled into the audio amplifier and R-33 attenuates the signal to a value closely matching the received signal under normal conditions. The emitter of Q-5 is coupled to the key through isolating diode D-3 which is required because of the relatively high voltage employed in the transmitter section.

Spotting Oscillator

A single transistor calibration oscillator is provided and it's output is sufficiently low to prevent blocking or overloading of the receiver. The calibrator uses the transmitting crystals. For simplicity, no means were provided to switch the crystal from transmitting to spotting, consequently it is necessary to plug the crystal into either the transmitter crystal socket or the calibrator socket as required.

Transmitter

The transmitter is a push-pull crystal oscillator operating at approximately 8 to 10 watts input. It operates quite reliably with all forms of surplus crystals of the pressure holder variety. The small plated crystals will work in this circuit and are not harmed by the drive but will give a "yoop" to the dash-note due to crystal heating. The transmitter transistors, Q-8, Q-9, are forward biased by resistors R-20, R-21, R-22, and R-23 to approximately 50 to 60 mA with the crystal removed. If operating properly, the transistors will not break into oscillation with any setting of the transmitter tuning control. When a crystal is inserted into the socket, the current will rise sharply. A nice dip should occur at resonance much like that observed in vacuum circuits. The transmitter is link coupled to the antenna and a tuner is recommended for harmonic suppression whenever the transmitter is used into any-

thing other than a loaded whip. The small milliameter is a surplus unit and in conjunction with R-24 gives a full scale reading of approximately 250 mA. The transmitter is usually loaded to 200 to 230 mA, and at this input the transistors do not get appreciably warm during normal transmissions although under continuous key down conditions, it will get quite warm.

Practically the whole transmitter can be built onto a two gang broadcast tuning capacitor of the TRF variety with the transistor heat sink tabs soldered onto the stators. The effectiveness of the stator as a heat sink will become immediately apparent when trying to make this solder joint. In short, use a large iron. The attached sketch shows the mounting of the transistors and the terminal strip on which most of the transmitter components can be mounted. Almost any NPN silicon planar transistor having a 25° C. case rating of 2 watts or more may be used.

Current Limiter

A current limiter is provided for the protection of the transmitter transistors. It is characterized by low internal voltage drop as current increases until at the "knee" or transition point, the internal voltage drop rises to prevent further increase of current. As designed, this "knee" occurs at around 250 mA and when the load is short circuited, will pass only slightly more than 300 mA. A device such as this is absolutely necessary when operating transistors in an overloaded condition where secondary breakdown is likely to occur. The limiter action is instantaneous and prevents the breakdown from being catastrophic. The limiter operation is as follows: R 35 heavily forward biases the limiter transistor which passes current through R 34 to the load. When the voltage across R 34 approaches 1.2 volts which is equal to drop across diodes D 4 and D 5, the internal resistance of the limiter rises to prevent a further increase in current. The sharpness of this transition is a function of transistor gain. The limiter transistor is heat sinked to the chassis although it generates no heat during normal operation. Should a short or breakdown occur in the transmitter, however, the dissipation would be quite high. A fuse has been included although it has never been replaced.

Conclusion

The unit as described has been used for about 4 years now and has bounced around in the back of a VW camper for a good number of miles. Typical operation during daylight results in solid contacts at distances up to 600 miles using a whip antenna. The entire unit is constructed in an LMB W-1B chassis/cabinet combination, and the construction was accomplished without any crowding whatsoever. There does not seem to be much point in miniaturizing beyond a certain point, since operating convenience dictates reasonable size knobs, dials, etc., even though the electronic portions could be duplicated in a much smaller volume.

As an afterthought the prospective builder may want to investigate the use of the new plastic power transistors with tab mounted collectors. These include the GE 2N4057, TI TIP-14, or Motorola MJE340. The increased dissipation rating of these power units plus the fact that some are rated to 200 volts suggests that several times the power could be run by simply rectifying the 115 V mains. Including this simple 130-140 Vdc power supply within the case would result in a really small rig for its power. The prospective builder had better incorporate a 60 mA pilot lamp in the crystal lead for protection however, as was the practice in the day of the old Tri-tet oscillator.

. . . WA6JND

Double Conversion of the BC-348-M

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Hams in most of the world are lucky enough to be able to select their receiver from a vast variety of factory-made equipment, but in places like India, where there are relatively few amateurs, it is difficult to obtain even surplus communications equipment. As a result, you aren't apt to find many Indian hams with modern equipment. The only choice left is to make the most of the surplus equipment that is available.

Most of the surplus receivers available to us were quite suitable for operation during the 40's, but with modern operating techniques and the number of stations on the air, they are not suitable for present day operation. In this article I will present a few ideas on how to make the old BC 348 a moderate receiver for present day use.

It is converted into a double-conversion receiver with selectable upper and lower sideband. The second *if* of 85 kHz (obtained from an old BC-453) maintains good selectivity for normal operation. The front panel controls include main tuning, band switch, *rf*, *if* and audio gain controls, upper or lower sideband selection, antenna trimmer, BFO, calibration check, ANL, AVC on/off-fast/slow, AM or CW/SSB, tone and transmit/receiver.

Circuit

The ECC189 in the first *rf* amplifier is connected in the cascode configuration to utilize its low noise and high gain properties. The second *rf* amplifier is a 6BA6 with an *rf* gain control in the cathode circuit. Delayed AVC is applied to the grids of these tubes rather than through the *rf* coils as in the original circuitry of the BC 348. The first mixer and local oscillator are the same as originally designed, but the mixer was rewired on a new *rf* module along with the *rf* amplifiers. The regulated voltage to the oscillator is from the original neon bulb regulator.

A 6BA6 is used in the first 915 kHz *if* stage. The cathode bias is varied along with the first 85 kHz *if* amplifier with the *if* gain control. A 6BA6 in the second mixer converts the 915 kHz signal down to 85 kHz. The BC 453 *if* transformers are peaked at 85 kHz for maximum selectivity. These transformers are lightly loaded by tapping down on the winding, thereby maintaining the high Q necessary for good selectivity. A 12AT7 twin triode serves as two crystal oscillators—one at 1000 kHz. the other at 830 kHz. Upper and lower sideband selection is obtained by switching the proper oscillator into the mixer circuit.

Two 6BA6 85 kHz *if* stages provide the necessary amplification. Also gain can be realized from these stages, their primary function is to provide good selectivity. Their gain is controlled by varying the cathode biase with the *if* gain control.

The product detector in this dual conversion BC 348 consists of a heptode converter with a variable Hartley oscillator for the VFO. The incoming 85 kHz signal is applied to one grid and the local Hartley oscillator to the other—the product of the two signals is obtained across the plate load. If both signals are at nominal zero beat with each other, the oscillator signal replaces the missing carrier in a SSB signal. If the oscillation is off by 1 kHz, the result is a 1000 Hz audible note for CW reception.

In the AM mode a 6AL5 series rectifier demodulates the incoming AM signal. The detected AM signal is connected to either the series noise limiter, another 6AL5, or directly to the audio amplifier through the mode switch. The series noise limiter derives automatic bias from the incoming signal. The clipping level is controlled by the average carrier level. This type of limiter is only effective for AM signals and optimum operation is obtained at 30 to 40% modulation. It maintains best signal-to-noise ratio regardless of signal strength.

A 6AL5 provides shunt-type delayed AVC. The 6AL5 cathode is maintained at a fixed level by a voltage divider; this voltage allows

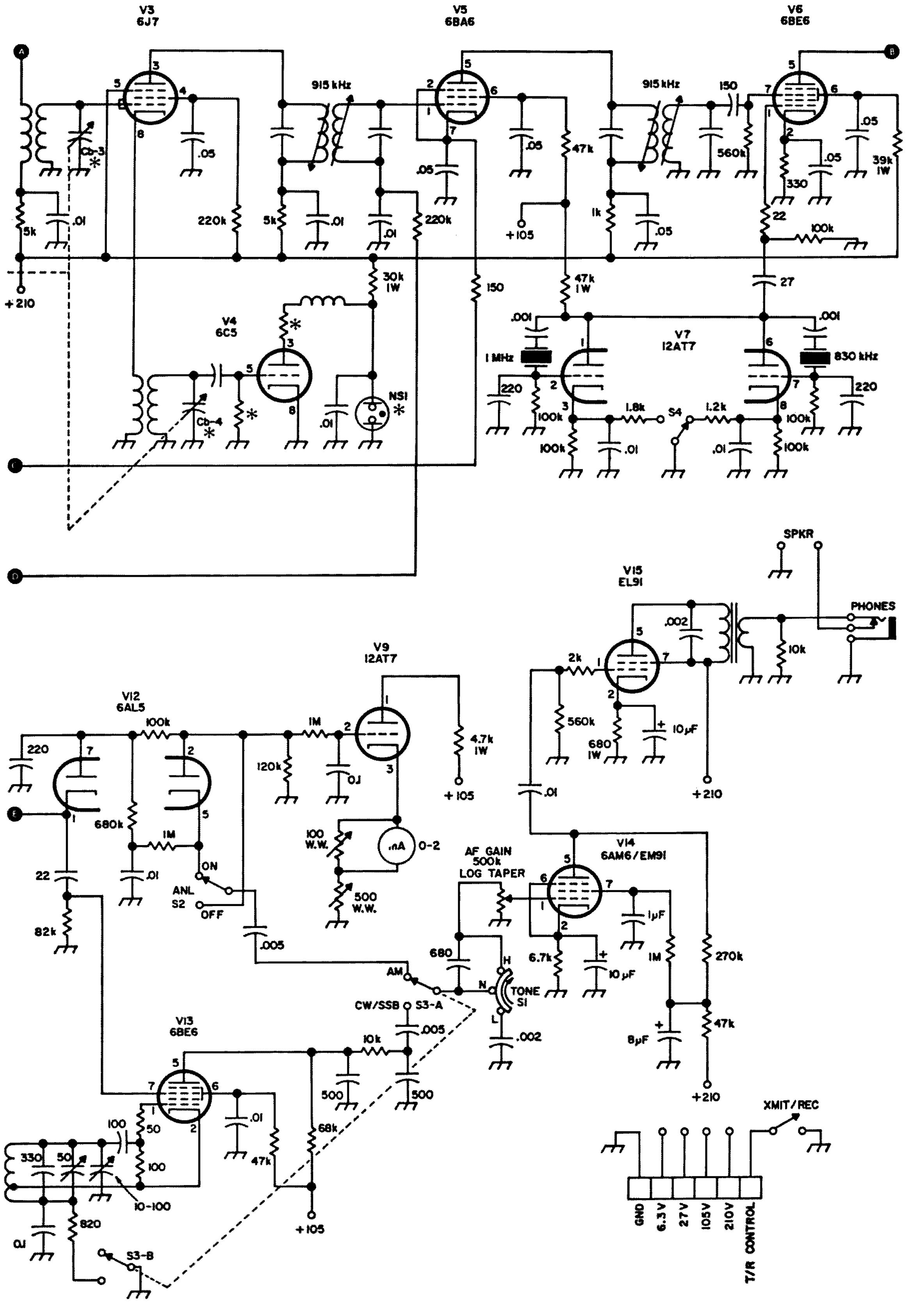

Fig. 1. The complete diagram showing modifications.

the signal to reach a predetermined level before the tube conducts and provides AVC voltage.

The audio signal from the product or AM detector is fed through the tone control switch to an EF91 audio amplifier. The tone control has three fixed position—high, normal and low. The EL91 audio output stage is a low power tube with low heater current to reduce the heat within the receiver. In communications work with a high-gain receiver, high audio level is very rarely required.

The S meter function uses half of a 12AT7 twin triode which obtains a varying carrier level from AM detector through an rc network. This section has a regulated plate supply and the meter is in the cathode circuit. The varying carrier level changes the tube current which can be read on the meter. With the aid of resistors VR-5 and VR-6, the meter calibration and sensitivity can be set.

The transmit/receive switching arrangement allows the receiver to be muted during transmit periods. When in the transmit position, the relay RL1 energizes and the following changes take place. 1. The antenna is grounded to avoid any high potential appearing at the *rf* grid. 2. The second *rf* amplifier cathode is poened making the stage inoperative. 3. The *if* gain control circuit is open and an additional resistance (VR-4) comes into the circuit. This additional variable resistor varies the sidetone level available while transmitting. In my receiver, there is also a 100 kHz oscillator to make dial calibration checks. The power for the circuit was obtained from the cathode output stage. In the calibrate position the antenna input is disconnected and the oscillator output is connected to the 1st *rf* amplifier.

How selectable sideband is accomplished

When a signal of 10,000 kHz is modulated by 1 kHz audio, the signal will consist of carrier at 10,000 kHz, an upper sideband at 10.0001 kHz, and lower sideband at 9,999 kHz. The incoming signal is heterodyned with the 1st conversion oscillator at lower than the incoming signal on the two higher bands, and the first *if* frequency of 915 kHz is obtained. Now, three new frequencies are available at the output of the first mixer.

The carrier at 915 kHz, the upper sideband at 916 kHz, and lower sideband at 914 kHz. These signals are heterodyned with the second conversion oscillator in the second mixer stage. The second conversion oscillator is crystal controlled at 1000 kHz and 830 kHz. The selection of one of them is done by switch S-4. As the second *if* is tuned to 86 kHz, the 830 kHz oscillator would give upper sideband (916 kHz of first *if*) and the 1000 kHz oscillator would give lower sideband (914 kHz of the first *if*). In the frequency conversion process the carrier still remains at 85 kHz. It should be remembered that the above conversion holds good only for band 5 and 6, where the first conversion oscillator is lower than the incoming signal. The operation of USB and LSB switching will be just the reverse in the case of the lower bands 1 to 4. Here the first conversion oscillator is higher than the incoming signal. An effective selecting of the sidebands can be established by reducing the bandwidth of the 2nd *if* frequency. This can be accomplished by making use of tapped points in the 85 kHz *if* transformers and by pulling up the secondary coil for loose coupling.

The circuit diagram does not include the power supply for the receiver. A suitable power supply unit can be built externally and connected to the receiver as shown.

Construction

The construction of the complete receiver is divided into three modules, each being externally wired and interconnected after they are placed in the original chassis. The wiring of the original receiver was completely removed except for the avc packs on which only the avc feed was changed. For ease in wiring, the original chassis frame between the inverter unit and the *if* assembly was cut away. The first module consists of *rf* amplifiers and the first mixer. This stage of wiring is easy as there are only a few components. After wiring, this module can be put in its original place. Access to the tube base connection is possible through the front panel opening. The second module consists of the detectors, *af* ampliers, and first *if* (915 kHz) amplifier. The third module contains the second mixer, 86 kHz *if* and the S meter tube. Most of the components of this module are placed on circuit boards and mounted close to the respective tubes.

Many of the components of modules 2 and 3 are circuit-boarded and the arrangement of components does require some constructional experience. The frame between the coil pack and modules 2 and 3 will accommodate all the supply distribution among the modules. To insure better chassis continuity, a metal braid interconnects the modules. The top view of the receiver does not show the 830 kHz crystal as the photo was taken prior to the wiring of the crystal. The output transformer takes the original place in the BC-348.

After construction, the alignment procedure is normal. Care should be taken while aligning the 2nd *if* stage that it is exactly peaked for 86 kHz, as this would determine sideband selection.

I am sure this unit would equal most of the moderately priced receivers on the market. Of course, for many of our ham friends who can buy one for cash, it may sound a waste of time to build his own receiver, but this is not the case in India where almost everything in the shack must be home-brew.

. . . VU2TV

The Gentrac

P. A. Lovelock
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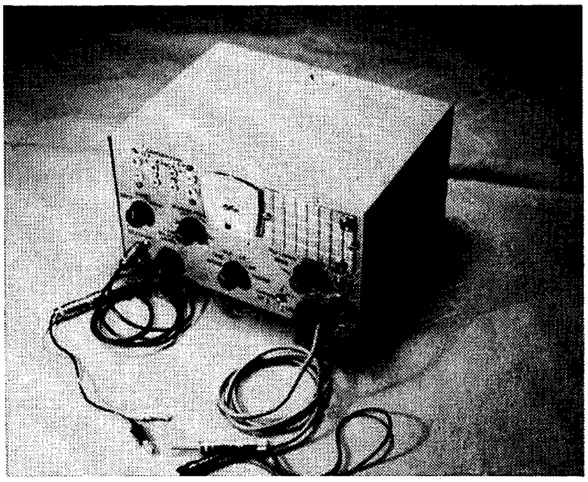


Ever been frustrated by a pyramid of test gear and that inevitable octopus of tangled leads and power cords, while trying to align or trouble shoot your receiver. Or perhaps, like me, the minimal closet space of modern apartment dwelling has prevented you from harboring much in the way of test equipment. In either event, you can use a Gentrac.

Originally conceived as a 'do-all' test set for receiver work, the Gentrac also possesses useful capabilities for transmitter and audio circuit testing in a single, transistorized package which can be used anywhere.

The Gentrac incorporates two individual units from which its name is derived:

1) A multi-purpose generator, furnishing the most needed signals for communications work
2) An *rf/af* signal tracer and output meter.

Only two test leads are required; one for generator output and the other for tracer input, eliminating the usual cats cradle that confounds the more conventional set-up.

Here is what the Gentrac has to offer:

Generator Specifications.

100 kHz and 1MHz calibrated markers up to 200 MHz Crystal controlled oscillator output in the range of 100 kHz to 30 MHz on fundamentals; up to 200 MHz on harmonics.

Audio sine and square waves over the voice frequency range of 250 to 2,500 Hz.

Broadband "white" noise.

Modulation of *rf* output by 250 to 2,500 Hz sine wave, or unmodulated.

Generator output low impedance, and continuously variable over a 60 db range for all signals.

Tracer Specifications.

Input impedance: selectable 1 megohm or 10 kohm.

Input Sensitivity (gain): selectable 150 μV or 3 mV.

AF input: Direct. *rf* input; with external probe.

Output: Selectable to internal speaker and/or VU meter

Circuit Description—Generator.

A schematic of the generator is shown in Fig. 1. For convenience the circuit has been divided into six basic sections by dotted lines, and labeled G1, G2, G3, G4, G5 and GO, being the individual Oscillator and output circuits as follows:

(G1 *Marker Generator.*—Q1 is a dual controlled oscillator, selectable for 100 kHz and 1 MHz output. Capacitors C2 and C3 permit accurate frequency adjustment. Q2 is a hormonic amplifier for the 100 kHz output only, providing markers well up into the VHF range.

(G2) *H.F. Generator.*—Q3 and Q4 comprise an untuned crystal oscillator functioning over the range of 3 to 30 MHz.

(G3) *L.F. Generator.*—Q5 is an untuned crystal oscillator functioning over the range of 100 kHz to 4 MHz.

(G4) *A.F. Generator.*—Q7 is an RC coupled, phase-shift oscillator, with good quality sine-wave output, continuously variable over the 250 to 2,500 Hz range. This oscillator also drives Q8 and Q9, which comprise a square-wave amplifier, for providing square wave output.

(G5) *Noise Generator.*—Diode D2 is a conventional noise generator, utilizing either a 1N21 or 1N23. The diode current regulator resistor R6a, is a potentiometer section ganged to the output attenuator R6b, Thus, while the output attenuator is not used with the noise generator, the noise

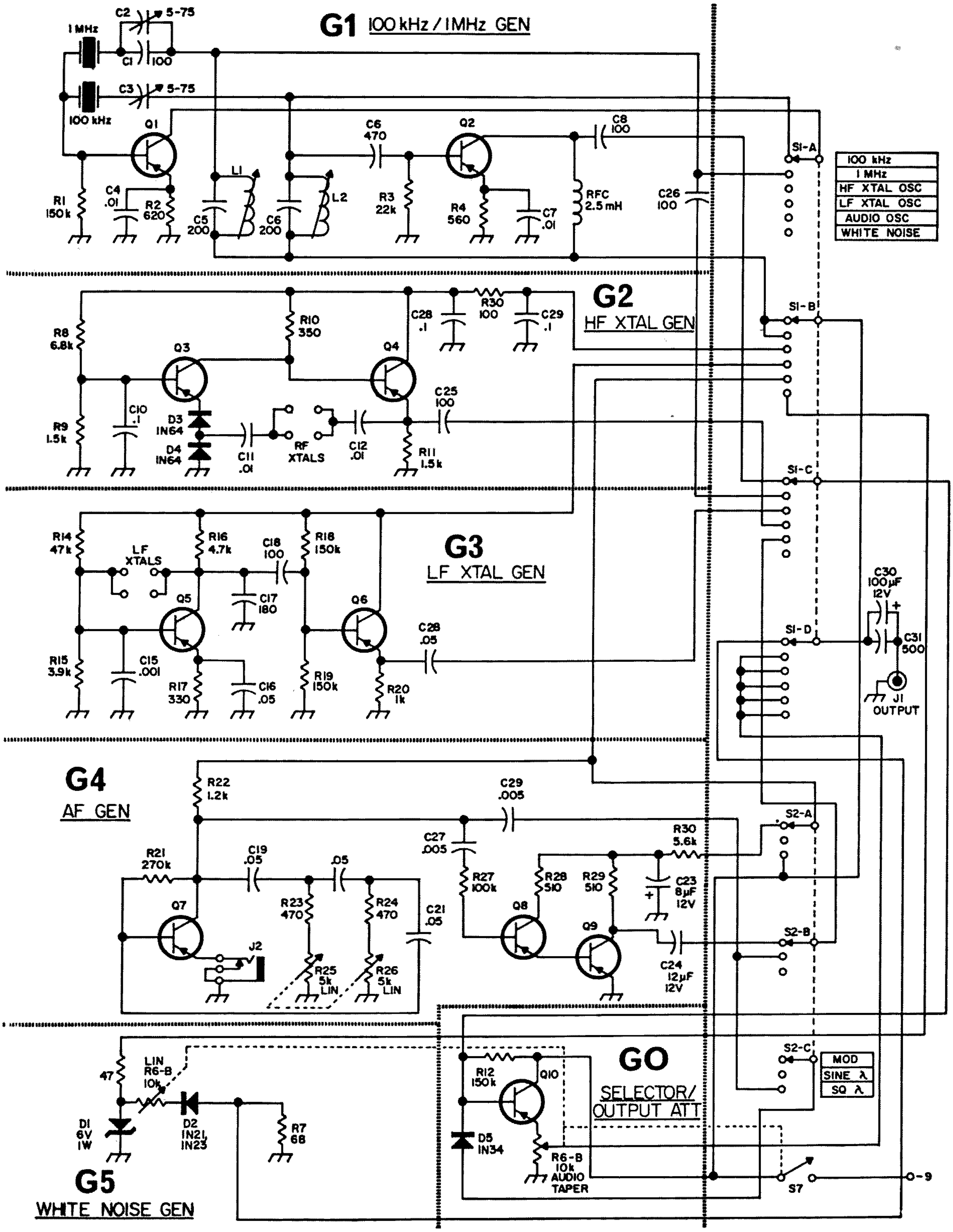
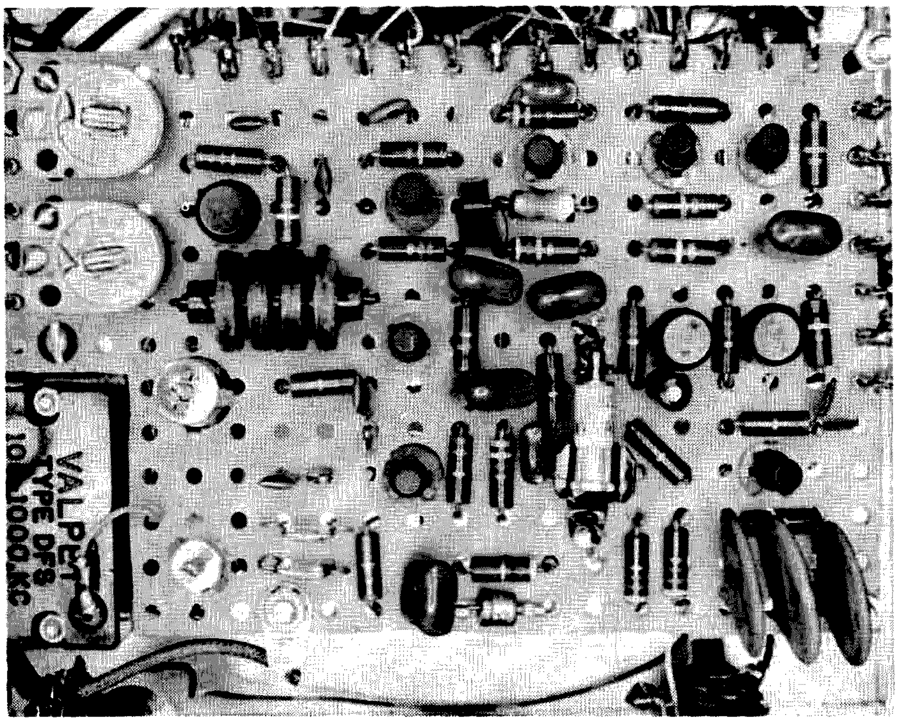


Fig. 1. The schematic of the generator.



Generator section component board layout.

output is adjustable with the same panel control. Voltage supply for the noise diode is stabilized by a 6V Zener diode (D1), so that noise output is unaffected by normal battery variation, and permits control setting to be used as a direct reference when making relative noise measurements. This eleminates the need for the usual diode current meter for reference purposes.

(*GO*) *Output/Attenuator Stage*. Q10 is an emitter follower which is the common output stage for G1, G2, G3 and G4. This stage provides low impedance output with negligible loading on the individual generator circuits. The output attenuator R6b, also functions as the emitter resistor for Q10. The generator mode switch, S1a, b, c and d selects the appropriate generator signal to be fed to the base of Q10, and also switches generator supply voltage. Sine wave modulation of Q10 is provided by the diode-modulator D5, when the *af* mode switch S2, is switched to the "MOD" position.

'*Circuit Description—Tracer.*

Fig. 2 is a schematic of the tracer section, which is comprised of a commercially available transistor amplifier (Realistic type No. 27-1557 or equivalent), together with the associated patching and switching functions. In addition an outboard emitter follower stage is incorporated to allow for selectable high impedance input, as well as the normal 10 k input impedance of the amplifier. Switchable speaker and VU meter provide aural and visual monitoring of the tracer amplifier output.

Input #1 (J3) is normally used for tracer input operation, and is switched for high and low gain by S5, and for high and low impedance by S4, both on the front panel.

Input #2 (J4) provides direct coupling to the transistor push-pull output stage, and may be used for one of the following purposes:

(a) Substitute output stage and speaker.
(b) Direct input to the VU meter (with tracer amplifier switched off) for measurement of high level signals.
(c) Tracer amplifier output for high impedance phones.
(d) Output for oscilliscope to observe low-level *rf* or *af* signal picked up by the tracer.

(J5) permits using the internal speaker as a substitute with an external amplifier, and disconnects it from the tracer amplifier.

(J6) is output for low impedance headphones, disconnecting the internal speaker.

Decoupling of the internal battery supply is accomplished by a 27 ohm resistor and 500 mfd capacitor, to prevent interaction between the generator and tracer when used simultaneously.

Construction.

The entire generator circuitry, excluding front panel controls and crystal sockets, is mounted on a 5¼" x 3½" piece of perfboard (0.093" holes). Layout of the components is shown in the photo.

Good grade, mica-filled sockets were used for transistors. Alternatively transistor leads may be permanently soldered to flea clips staked in the perfboard.

The generator board and tracer amplifier are mounted in the 4½"h x 8"w x 6"d aluminum mini-box by means of standoffs. The stand-offs used by the author are assembled from ½" and 1" spacers, normally intended for expandable three-hole binders, and obtainable from any good stationary store. These spacers have 8-32 threaded studs at one end and threaded inserts at the other end, accepting 8-32 screws and nuts for attachment to the boards and box. The spacers may be connected together to assemble the desired length. Two 1" and one ½" make up each of the four spacers to mount the generator board. Four ½" spacers support the tracer amplifier and two 1" spacers attach the input emitter-follower stage to two of the tracer amplifier mountings.

The crystal used in the (G1) Marker Generator is a Bliley dual 100 kHz/1 MHz unit which was available in the authors junk box. In the event difficulty is encountered in obtaining this unit, individual crystals may be mounted in the same board space. All the generator circuits were adjusted to permit common usage of the GE2 and GE9 transistors, since these are commonly available just about anywhere. However other suitablé transistors may be substituted and the individual constructor may want to experiment with what is available. Substitutes for the GE2 may be any audio frequency PNP transistor with an hfe of about 70. Substitutes for the GE9 should be high frequency PNP types, preferable good to 100 MHz minimum, with an hfe around 100.

Location of controls is shown in the front panel photo. One each HC6/U and FT243 type crystal sockets are mounted on the front panel for both the HF and LF generator, in order to allow almost any crystal to be plugged in.

The Gentrac is powered by a Burgess type D6, 9V battery, or equivalent type. Smaller

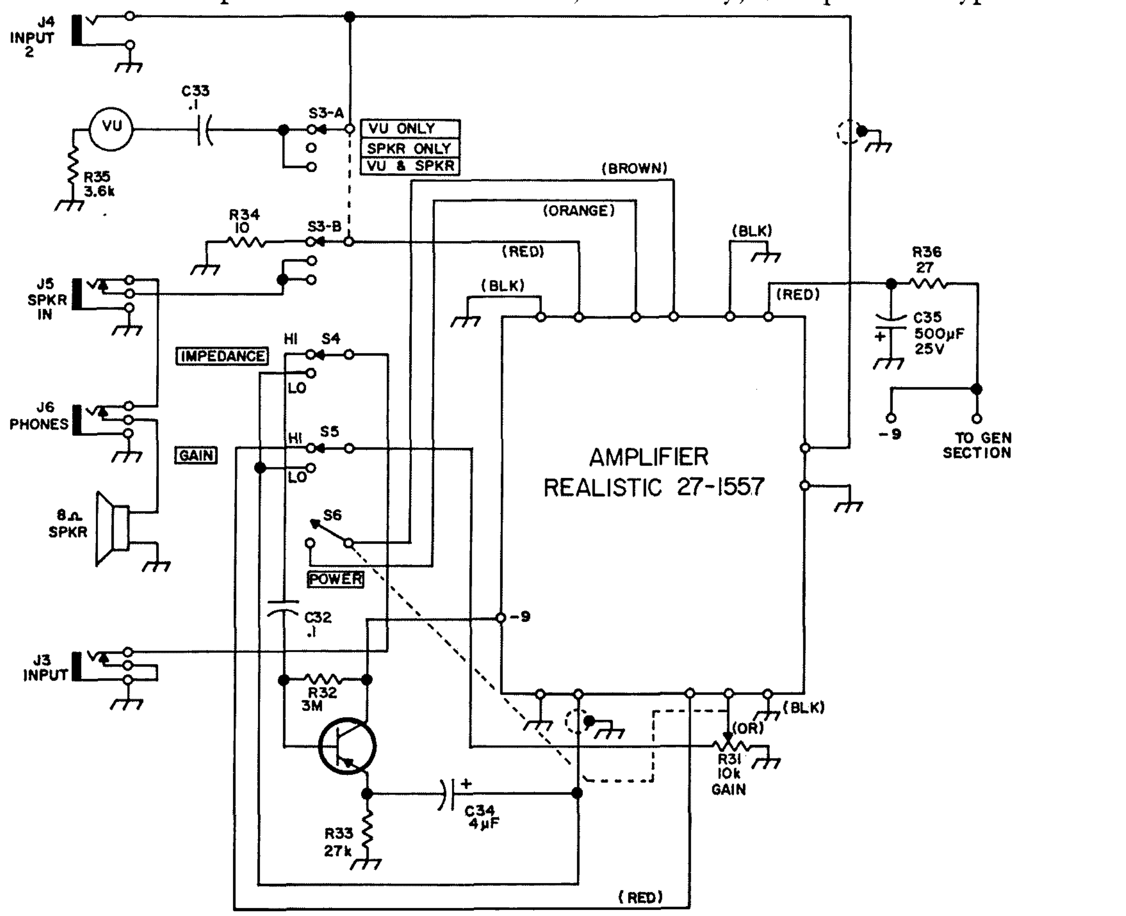
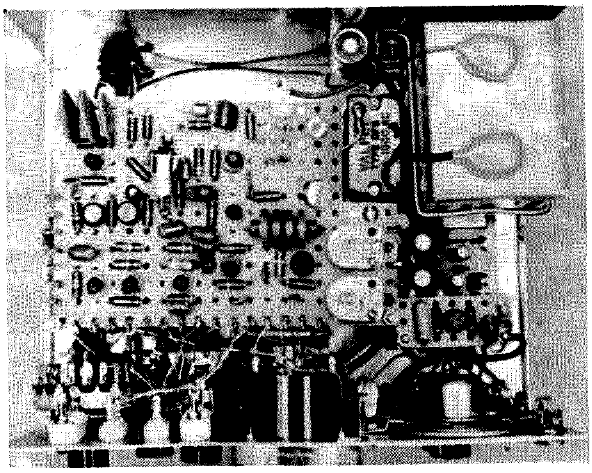


Fig. 2. Schematic diagram of the tracer section.



The Gentrac—Interior view.

9V batteries are not recommended for reliable operation, particularly since the drain of the noise generator is substantial. The battery is secured to the back of the mini-box by a wire-clamp fabricated from a wire clothes hanger. The springiness of this wire holds the battery securely while permitting it to be removed when required.

The two test leads and *rf* test probe are assembled as shown in **Fig. 3.** Any small diameter shielded single conductor cable may be used for the tracer cable. For the generator output cable, miniature coaxial cable (type RG 174/U) is recommended. If this is hard to come by good quality shielded single conductor may be used with some loss at higher frequencies.

The 1N34 diode used in the *rf* probe is of the larger glass type, since this fits snugly in the phono connector, with one glass seal forming an insulator between the wire-lead probe and the connector housing.

Using the Gentrac.

The first question may be, "Why crystal oscillators for the generator". Obviously the Gentrac does not substitute for a precision, wide range signal generator. But just as obviously a crystal oscillator will give a more accurate discrete frequency signal than a low cost, tunable signal generator. A handful of low priced crystals will do a lot in the Gentrac. For example a couple of crystals at 262 kHz and 455 kHz for use in the LF generator, will cover most *if* alignment needs. A 10.7 MHz crystal in the HF generator is handy for aligning the *ifs* of FM receivers. Ham band crystals are good for 'band finding' when calibrating a home-brew receiver, prior to accurate calibration with the marker generator. Specific frequency crystals can be obtained for special purposes, such as the *ifs* of transceivers at 5.0, 6.0 and 9.0 MHz, and will make possible accurate alignment with assurance and repeatability not possible with the average tunable signal generator.

Referring to the front panel photo, use of the controls is fairly apparent. The generator is turned on by advancing the output control from fully counterclockwise. Generator Mode switch selects the desired signal. In the HF and LF modes a crystal is plugged into the appropriate socket. The crystal oscillators require no adjustment or tuning and will work with any active crystal within their range. In the *AF* mode the Audio Freq. control is adjusted to the desired frequency. Accurate calibration of this control was not attempted on the authors unit since approximate frequencies in the audio range (e.g. 400 Hz, 1,000 Hz) are usually adequate.

However a few adjustments are required when first setting up the Gentrac. The Marker Generator requires zero-beating the 100 kHz and 1 MHz outputs against WWV, by adjusting C2 and C3. After this LI and L2 should be tuned for maximum output. You can use the tracer with the *rf* probe plugged into the generator output and observe the peak on the V.U. meter, but the *af* mode switch must be in the "MOD" position. Adjust the output control and the

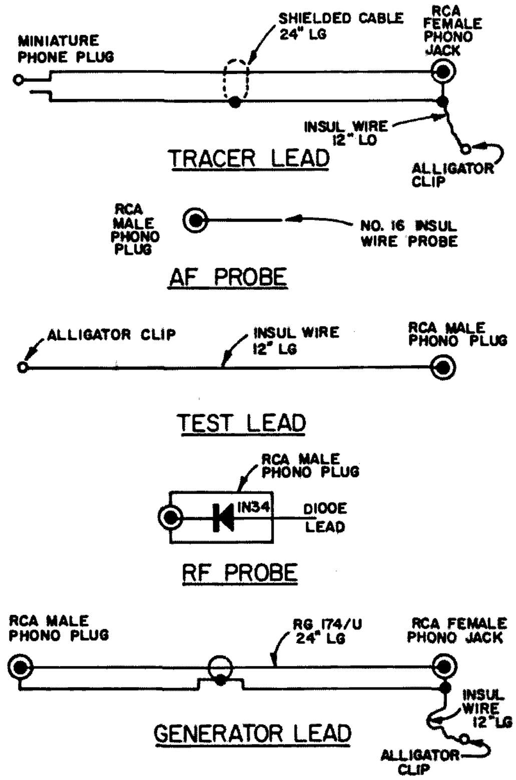
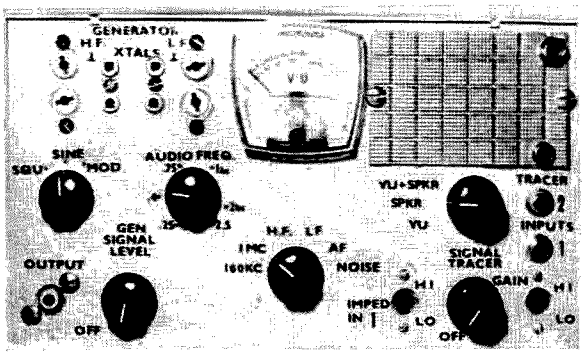


Fig. 3. Test leads and rf test probe construction.



The Gentrac front panel

tracer gain for a suitable reading. The approximate *af* frequency markings for the AUDIO FREQ. control may be spotted by hetrodyning the output against a borrowed audio generator, or a frequency test record on the Hi-Fi system.

A typical application for the Gentrac in aligning a communications receiver is as follows:

1) *if Alignment*—Generator Mode switch to LF and 455 kHz crystal in LF socket. *af* Mode switch to "MOD". AUDIO FREQ. control at .4 (400 Hz). Connect generator output cable to converter stage grid, and tracer input lead to receiver audio output. Tracer input switches to Low Impedance and Low Gain. Tracer output set to VU. Set generator output and tracer input controls for suitable VU reading and peak *if* transformers.

2) *Dial Calibration*—Generator Mode switch to 1 MHz. Generator output to receiver antenna input, and adjusted to suitable level. Adjust receiver trimmers for markers at 1 MHz dial markings.

3) *RF Alignment*. Generator Mode switch to NOISE. Generator output to receiver antenna input. Tracer input to receiver audio output. Generator level control full clockwise. Tracer gain control set for suitable VU meter reading. Peak *rf* and converter stage trimmers for max noise level on VU meter.

Many other uses for the Gentrac will suggest themselves. The tracer is conventionally used for locating signal loss or distortion, using the appropriate probe, when receiver trouble shooting.

With a telephone pickup coil plugged into tracer input #1, you can have a handy telephone amplifier. And for a little code practice, patch the generator output to the tracer input, plug a morse key into J2, and set the Generator Mode switch to *af*. When used as a practice oscillator square wave output may prove less fatiguing than sine wave, and you can adjust the *af* frequency to your own liking. Incidently J2, which keys the *af* oscillator, is mounted on the back of the minibox, and may be excluded if not required.

. . . W6AJZ

Organizing a Resistor Collection

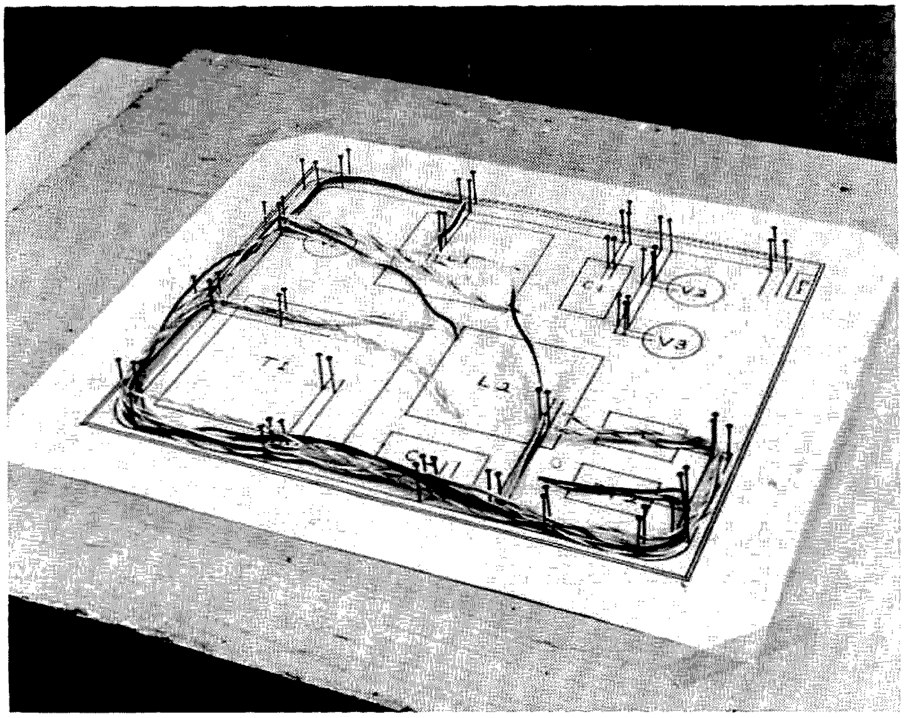
A simple, yet effective way to organize your supply of resistors is found in last years parts catalogs. For years I had all of my resistors thrown in a box, each time I needed a particular value I had to rummage through the entire box to find it. The answer to this problem lies in a small cabinet with twelve drawers. Thumb through last years catalogs to the resistor section. Cut out the table of standard values. I used the IRC 10% table from Allied Radio's catalog. The 5% table would provide a more complete listing, but it may be too large to fit the drawer fronts. You will note that the table is divided into twelve columns, cut these apart and glue or tape them to the fronts of the drawers. This simple system saves 90% of your resistor locating time, looks neater, and helps you keep a balanced supply on hand.

William P. Turner WAØABI


"He's left me before—but this time I think he means it."

Harness Your Wiring

A. E. McGee, Jr. K5LLI
2815 *Materhorn Dr.*
Dallas, Texas 75228



When building any complex piece of electronic equipment, you will usually find that the majority of the wiring consists of power and control wiring of one kind or another. This wiring is usually completely uncritical as to length and placement, so ordinarily not much thought is given to its installation. Any method of wiring may work well electrically, but later on, when it is necessary to trouble-shoot the circuit and make repairs, you may find that you have built-in some unnecessary troubles.

If you wire directly from point to point, always using the shortest possible wire, the wires will cross each other at many odd angles and will very likely pass over other components. This makes access to these components difficult. Also it is hard to find a clear path for the signal wiring when power leads are everywhere.

A much better plan is to run the non-signal wiring around the sides of the chassis, bound together into a neat bundle, with leads breaking-out at right angles near each component. A wiring harness like this is most easily made outside of the chassis. A little time should be spent in preparing a wire chart and a full-size layout of the chassis. This will speed the construction of the cable and make errors unlikely; also, you will have a complete record of where each wire goes in the circuit.

The wire chart and chassis layout

To make a wire chart, rule off five vertical columns on a sheet of paper, and mark them with these headings: Wire No., Size, Color, From, and To. Under Wire No., number the wires consecutively; under Size, put the gauge of the wire; under Color, use the standard color code (a red wire would be 2, a white-blue-green wire 965, etc.); under From and To, put a description of the components or terminals to which the wire is to be connected.

Now draw a full-size layout of the chassis. This need only be a simple outline of the chassis, with the approximate location of all the major parts drawn in. Decide where you want the main body of the cable and the breakouts to the components to run, and

sketch them in. Use this layout, together with the schematic, in making the wire chart.

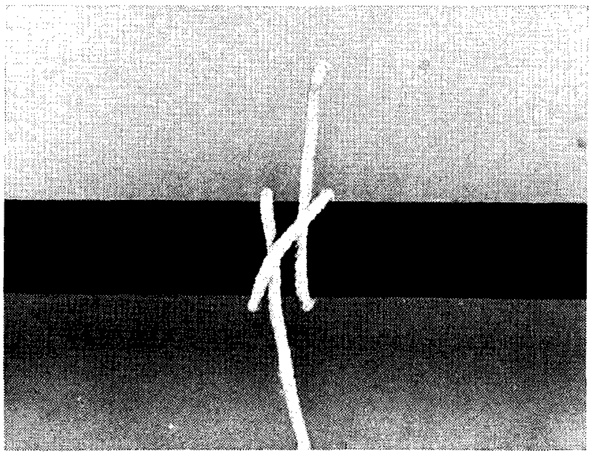
Start from one side of the circuit diagram and begin filling in the wire chart, marking through each wire with a colored pencil as it is put down on the wire chart. For example, say you start with a white, 18-gauge wire from the power switch to the primary of the power transformer. You would put down something like this: Wire No. - 1, Size - 18, Color - 9, From - S1, To - T1, terminal #1. Then mark the schematic to show which part of the wiring is now on the wire chart. A fairly large-size copy of the circuit diagram is helpful.

The chassis layout is useful when several components are connected to the same wire. The order in which the components appear on the schematic may be considerably different from their relative locations on the chassis. Reference to the chassis layout when making the wire chart will prevent excess wiring in the cable, caused by the same wire doubling back on itself to get to a previously-skipped component.

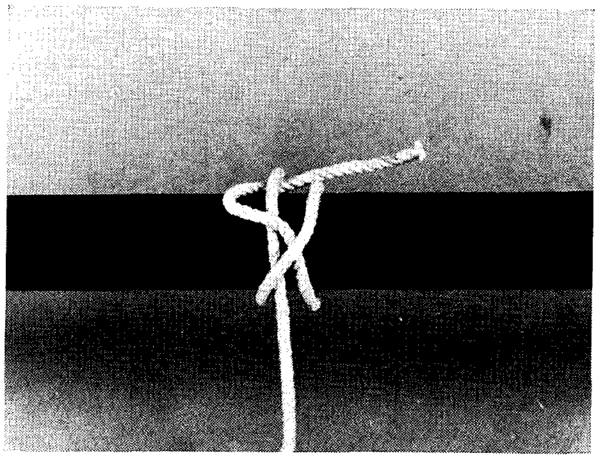
Use wires of as many different colors as possible. Assortments of small quantities of wires in various colors and sizes are available at bargain prices from most of the large mail-order parts distributors. You can use the colors according to some code of your own making, or just use them consecutively, and when you run out of colors start over again.

Making the harness

To make the harness, first tape the full-size chassis layout to a piece of wood. Drive some small nails along each side of the sketched-in cable. Place the nails in pairs



The clove hitch.



An extra tuck is added to the clove hitch to prevent its loosening.

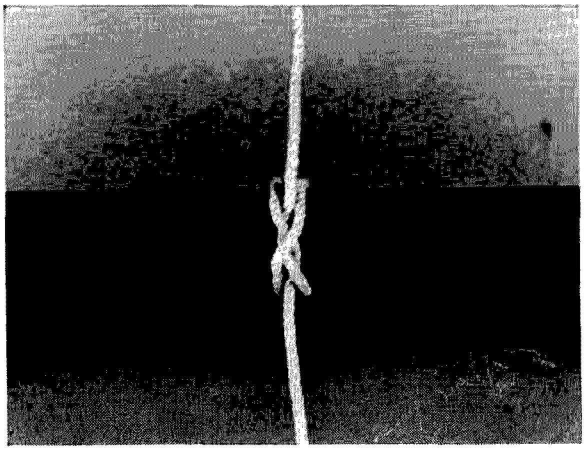
and space them about one-half inch or so, depending on the number of wires in the cable. Refer to the wire chart and begin to lay the wires in place. Put a check mark beside the wire number on the chart as each wire is put in. Be sure to leave sufficient length at the ends of the wire to allow making the connections. The wires may be stripped and tinned at this time, but a neater job will result if you leave this until after the cable is put into the chassis.

Lacing

When all the wires are in place, you can start binding them together. There are a number of different types of wraps, ties, and bindings that can be purchased, but in my opinion the neatest and simplest method for a small project is to tie the cable together with cord. Special lacing cord is available, and the flat nylon braid type will do a very attractive job. Any type of heavy twine will do about as well however. It should be large enough in diameter that it won't cut into the insulation.

The wires may be laced together, or simply tied at intervals. I prefer to tie them, as it is more secure and takes little more time than lacing. Lacing is recommended, however, when long runs of cable are made up. Tie the cable every few inches along the main body, and place a tie on both sides of each breakout.

A good knot for fastening the wires is a modified clove hitch, or ordinary clove hitch with a square knot tied over it to lock it. If maximum security is desired, put a drop of glue on each knot. For the nicest-looking job, the knots should be under the cable,



The completed modified clove hitch.

where they will be out of sight. The easiest way to do this is to first make enough temporary ties to hold the harness together. Then carefully remove it from the jig and turn it over. Finish the ties with the harness upside-down, and the knots will come out on the bottom when the harness is turned rightside-up.

The harness may now be mounted in the chassis. Hold it in place with a few cable clamps. Metal and plastic clamps are available in many different sizes. The plastic types are not as likely to cut into the cable, and will not cause a short circuit even if they do.

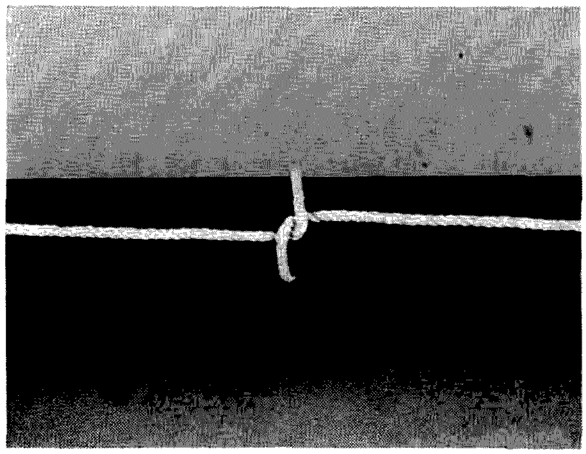
Route the leads to each component and cut them to length. Leave a little extra lead length at the end of each wire. This is called a service loop, and is very helpful if the connection must be taken loose and resoldered when replacing a component. It also keeps the wire from putting any strain on the connection. It is best to run the wire straight, and then make the loop right at the connection.

Tinning and soldering

All stranded wire must be tinned after stripping. This takes only a few seconds, and if it isn't done, the ends of the wires will fray and spread in all directions when the wire is wrapped around a terminal. Heat the wire before applying the solder, so that when the solder is applied it will quickly flow between the strands.

Strip enough of the wire so that when the connection is made, the insulation will be back about 1/16" or so from the connection. This will help to prevent burning the insulation when soldering. Don't put a sharp bend in the wire within ½" of the connection, as the heat of soldering may cause the insulation to pull away from the wire.

The above applies to the use of most plastic or rubber insulated wires. Teflon insulation is not affected by soldering iron heat, and cannot be burned or melted accidentally. Although Teflon-insulated wire is expensive (about 4 or 5 times the price of vinyl insulation), it is very useful when many wires must be soldered in very close quarters. Besides being heat-resistant, the electrical and mechanical properties of Teflon are excellent.



The proper method of lacing.

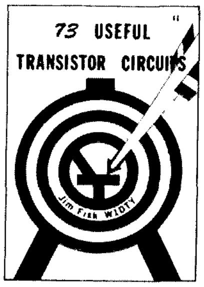
If you wish to replace a wire in the harness for some reason, you can do so by soldering a new wire to one end, and by pulling the other end the new wire may be drawn into the harness. Make a small lap-type solder joint, and smooth off any rough edges before pulling it through.

The information given here should not be taken as the last word on the subject. However, the use of this outline, together with ideas of your own, should make it possible for you to do a very professional-looking wiring job on your next project.

. . . K5LLI

BUY 73 BOOKS

73 USEFUL TRANSISTOR CIRCUITS



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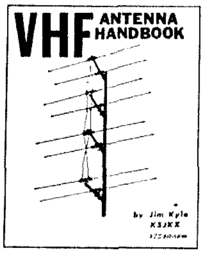

This handbook by K5JKX is a complete collection of information about VHF and UHF antennas, with design hints, construction and theory. If you've been wondering what array you need, this book will give you enough background to make the right decision. **$3**

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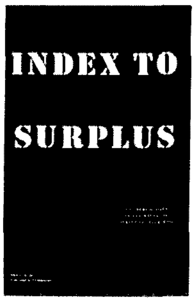

Do you have a piece of surplus equipment that you want to convert but can't find an article? If so, this is the book you need. It lists all of the surplus articles and conversions in popular electronic and amateur magazines from 1945 to 1966. **$1.50**

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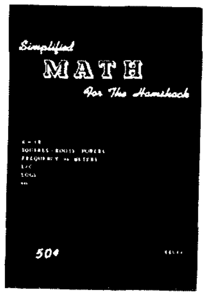

Does math scare you? It shouldn't in this easy-to-understand book K8LFI explains the simple exponential system of arithmetic, simple formulas, logarithms, and their application to the ham shack. **50c**

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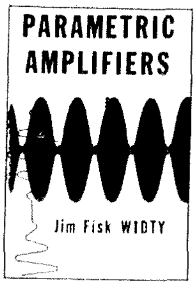

For the ham who wants to work DX on the bands above 432 MHz, there is nothing that can beat the gain and noise figure of a paramp. This book shows you how they work and how to build and use them. Lavishly illustrated with photographs and drawings. **$3**

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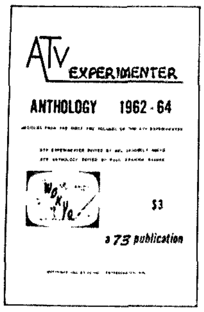

The Amateur Television Anthology is a collection of the technical and construction articles from the **ATV Experimenter,** edited by WØKYQ. If you're interested in ATV, this is the book for you. It covers the gamut from the simple to the complex in amateur television equipment. **$3**

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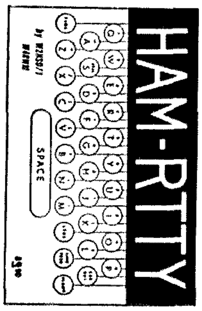

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73 Magazine

Peterborough, N. H. 03458

Copper Wire

Jim Ashe W1EZT
P.O. Box 343
Peterborough, N.H. 03458

Wire is so closely associated with electronics that it comes as a surprise to think there is an electronic component called 'wire.' Yet that is a very good way to think of the stuff that comes on spools, is measured in feet, available almost anywhere, and whose correct application is necessary for building reliable gear.

Looking inside a wire, we usually find copper. Copper is a very important metal, and electronics as we know it could not exist without that easily obtained, malleable, ductile, solderable, copper-colored stuff we call copper.

Copper wire in electronics

Copper is second only to silver in its good current carrying properties, and it is far less expensive. The difference in current conductivity between copper and silver is considerably less than seems to be generally believed, amounting to about 6% at dc. The difference is smaller at *rf*. See **Fig. 1** for relative resistances of some metals often seen in electronic chassis.

Copper has one unwanted property: it tends to work-harden. A piece of soft copper wire, once bent, never returns to its original soft state. It becomes harder and more crystalline, and prone to brittle fracture. Under conditions of vibration, #22 and smaller wire has a tendency to crystallize and finally break. And some insulation, stripping tools will nick a copper conductor, increasing chances of breakage at the nick, which is partly hidden by the insulation.

The tendency to break, noted in solid conductors, is greatly reduced by making the conductor of many fine strands. See **Fig. 2.** Reliability under vibration is greatly improved and the conductor is better able to withstand the stress of unsoldering and resoldering, although less convenient to work with. Flexible power cables are made of stranded copper wire.

Metal	Resistivity Compared to Copper
Silver	0.95
Copper	1
Gold	1.4
Aluminum	1.6
Iron	5.8
Tin	6.7
Solder (63/37)	9.3

Fig. 1. Resistances of several metals compared to copper. For example, if a certain piece of copper wire had a resistance of 1 ohm, a piece of iron wire with the same length and cross-section area would have a resistance of 5.8 ohms.

Some metals will react violently when exposed to air or water. Copper is very well-behaved, and stays clean and shiny for some time upon exposure to air. But it eventually becomes darkened by an oxide coating, after a few months. This can be very important in *rf* applications, and will be explained later. Copper will react quickly with body greases and acids commonly present on the hands, so that a shiny clean surface will take permanent fingerprints. And copper will react slowly with some chemicals to form a greenish nonconducting film or scum. Cleanliness is important when working with copper.

Electronics applications for copper wire fall under two general headings, dc and *rf*. At dc and power frequencies, conduction is distributed through the entire volume of the copper wire. Current flows in the center of

Wire-Size	Stranding				
12 AWG	19x25				
14	19x27,	41x30			
16	19x29,	26x30,	65x34		
18	7x26,	16x30,	19x30,	41x34,	65x36
20	7x28,	10x30,	19x32?,	26x34,	31x36
22	7x30,	16x34,	19x34?		
24	7x32,	19x36?,	45x40?		
26	7x34				
28	7x36				
30	7x38				

Fig. 2. Stranding of some popular wire sizes. The finest stranding is most flexible. This table was built up from an industrial electronics catalog, and several errors were found. The values followed by a question mark may be wrong.

Wire Size	mV/amp-ft. 20 deg. C	mV/amp-ft. 75 deg. C
12 AWG	1.6	1.9
14	2.5	3.1
16	4.0	4.9
18	6.4	7.8
20	10	12
22	16	20
24	26	31
26	41	50
28	65	79
30	103	126

Fig. 3. Wire resistance stated the most convenient way for several popular wire sizes. Resistance rises as the wire becomes warmer.

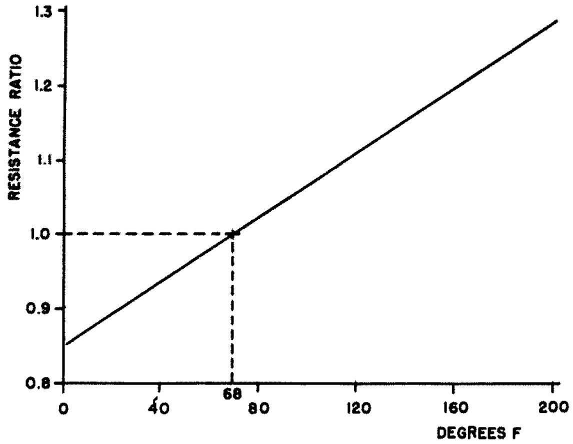


Fig. 4. Ratio of hot resistance to room temperature resistances for determining transformer operating temperature.

the conductor as well as the outside. But at *rf* the current is confined by magnetic effects to the conductor surface, which is why hollow conductors are often used in power *rf* gear. It is not economical to purchase copper when it will not carry current, and sometimes the space is conveniently used to carry cooling water. The frequency dividing line between dc volume conduction and *rf* surface conduction is not sharp.

dc and power wiring

Conductor cross section is the area available to carry current. To determine a conductor cross section value, imagine you have cut squarely across the conductor, and estimate the number of square inches, centimeters, or what have you, of area exposed. Circular mil measure is sometimes used, but is not required for electronics work. The conductor cross section has no direct bearing on how much current the conductor can carry, since tests at 15,000 amps/square mm (about #17 wire) show no indication of an intrinsic limit. The maximum or operating current is determined by one of two factors: excessive voltage drop, or excessive temperature rise.

Various tables in handbooks and physics tests may be used to calculate resistance values, but for most applications there is an easier approach. Resistance is commonly specified directly for various wire sizes in ohms per 1000 feet. This can be read as milliohms per foot, and a key trick in using this value is to read it as millivolts drop per amp-foot. See **Fig. 3**. In this way, calculations can often be completely avoided. You have to remember to allow for the current return path too, in estimating the voltage available at the end of a conductor or run. Good technique is to measure the result in the finished gear.

Wire resistance increases as temperature rises. See **Figs. 3** and **4.** The increase is not significant for most electronic applications, being in the order of 2% per 10 degrees F. This small change in a small resistance is rarely significant, but may become an important factor in transformer operation.

How hot does a given transformer actually become in normal operation? Straightforward resistance measurements can provide an answer. If the room temperature resistance of a winding is known. **Fig. 4** may be used to estimate operating temperature from the hot resistance of the transformer winding. If a very enclosed experimental device has been through two or three transformers even though they do not seem to be overloaded, this can be a very informative test.

Transformer temperatures are important in another way, too. A transformer can go into thermal runaway, if conditions are right. In normal operation the transformer power dissipation is directly proportional to its temperature rise, and the resistance also increases directly to the temperature rise. In this conditionally stable situation, transformer operating temperature is related to load. If another factor comes in, such as internal leakage that increases significantly with temperature, or circuit load requirements that rise with temperature, a thermal runaway situation is possible. Since it does not

Wire Size	Free	Application Cable	Transformer
12 AWG	41 amps	23 amps	9.3 amps
14	32	17	5.9
16	22	13	3.7
18	16	10	2.3
20	11	7.5	1.4
22		5	1.2
24		4	.73
26		3	.46
28		2.2	.29
30			.18

Fig. 5. Suggested maximum current for wire in various applications. Wire in a transformer is least able to dissipate heat, and is rated at the least operating current.

go too fast, perhaps it can be detected by plotting transformer temperature over time, with a cooling off period between tests. This goes slowly, but it may explain catastrophic failures that otherwise simply do not make sense.

When voltage drop in wiring is not a consideration, which is most of the time in amateur and experimenter electronics, the choice of wire size is determined by temperature and insulation considerations. Temperature is important, because insulation failures are generally keyed by excessive temperatures.

Conductor operating temperature is that of the general environment, plus a bonus rise depending upon the current and ease of dissipating excess heat. See **Fig. 5**. Very enclosed wire in a transformer is rated at a much lower current than the same size wire in free space. If special insulation permits higher operating temperatures, the wire current rating is increased.

The place formerly held by rubber as an insulating material is now taken by thermoplastic insulations. These are usually a vinyl chemical compound, much better behaved and longer lasting than rubber, but thermoplastic. That is, they soften and melt if they become too warm. Typical maximum operating temperatures are near the boiling point of water, about 175-200 degrees F. Teflon insulation, now entering the electronics consumer market, is good for much higher temperatures, and special teflon-glass insulation works at temperatures near red heat. Teflon and teflon-glass insulations also have excellent *rf* properties.

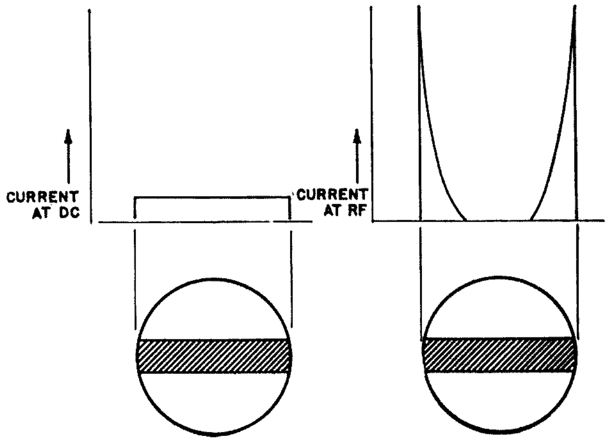


Fig. 6. If we could cut a thin slice from a wire carrying current at dc and RF without disturbing the current distribution, we would find a very basic difference in the way the current flows through the wire. In the RF case, there may be no current at all in the center of the wire.

Wiring at *rf*

There is a vague dividing line between *rf* and dc applications in wiring. It depends upon the application, permissible losses, and wire size, but is generally reckoned to be in the range of 50 kHz to 1 MHz.

If two adjacent wires carry dc or ac current in the same direction, they will be pushed away from each other by their similar magnetic fields. Imagining that a single large conductor carries many tiny current paths, we see that something like this might occur in single conductors. This actually is the case, and its result is called 'skin effect.' See **Fig. 6**.

Because only a small part of the wire actually carries the current its resistance appears greater than at dc, in proportion to frequency as shown in **Fig. 7**. Resistance at *rf* is always greater than dc resistance, and

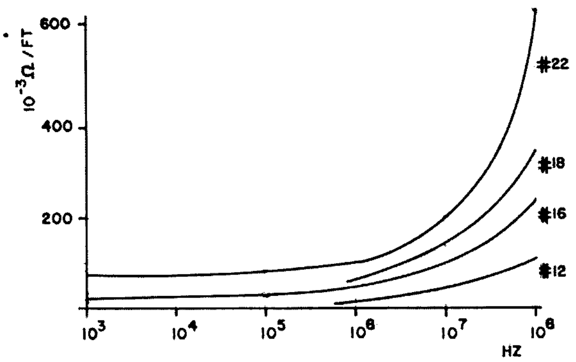


Fig. 7. Resistance of some popular sizes of shiny copper wire rises as frequency is increased. The largest wire always has the least resistance. Flat wire would show a much smaller frequency resistance dependence.

this explains why dirty or corroded *rf* conductors will not perform as well as clean, shiny ones.

In the process of working out this chart, some interesting facts appeared. Tinned conductors are not as good as shiny copper conductors, and there is little to be gained by silver plating. Because the tin is applied to the wire surface and has a much higher resistivity than copper, *rf* losses are relatively high. And since *rf* resistance resulting from skin effect varies as the square root of resistivity, silver plated conductors are but slightly better than shiny copper ones. The difference appears with aging, and may be minimized by a protective coating over the copper surface once construction is completed. This note should be especially useful to radio amateurs with old, dull open wire transmission line extending to expensive or carefully built VHF antennas.

This skin effect data also indicates how best to make good, high-Q *rf* and VHF coils at least expense. New copper wire is indicated and it should have an enamel or preferably a formvar coating. Silver plating is not required, and if possible the wire is flat rather than round. Both types of wire are commonly available from motor repair shops, which usually carry on a rewinding business in a back room.

Other copper materials for *rf* work are roofing copper, easily formed and cut into straps, and copper coated PC boards. The very best in this department is the two-sided glass-epoxy boards in 1/16 and 3/32 inch thicknesses, which probably have better mechanical and temperature characteristics than heavy metal.

Insulation

Insulation restrains the current to its intended path, and rarely has a mechanical function. Insulation should always be viewed with suspicion, and tested where its quality or reliability may be in doubt. This applies to all surplus wire. And some insulations show very high losses at *rf*.

Insulation failures may involve many factors. Oxidation is a natural enemy of rubber insulations but does not seem to affect the more popular vinyl insulations. Fungus may be important in very warm, humid regions, and sometimes oils and greases give trouble. Abrasion may cause failures in mobile applications, and manufacturer's specifications on voltage rating should be followed. But the most significant factor in amateur and experimeter applications is temperature.

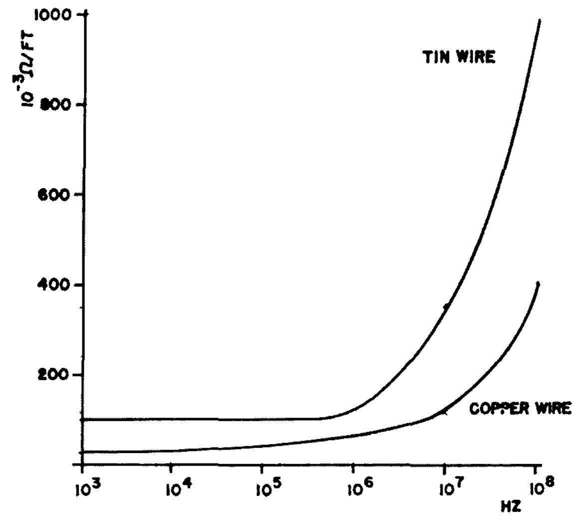


Fig. 8. Actual resistance of a tinned copper wire will be greater than shiny copper wire but less than solid tin wire, except at highest frequencies. It depends upon the thickness of the tin coating.

Temperature melts some insulations, and accelerates aging of others. It has a drastic effect upon insulation resistance. The MIT Radiation Lab Component Handbook lists an insulation resistance change by a factor of 48 in 20 degrees C. temperature change. This could be very significant in some critical circuits, and in transformers.

The common insulations used in electronics are the vinyl and polyvinylchloride types, enamel and formvar, and rubber. The vinyl insulations are most generally used and teflon is coming up fast due to its popularity in computer applications. Teflon has nearly perfect properties. Formvar is very good for coils and VHF circuits, and rubber is still used sometimes in power cords. Avoid rubber.

Installing wiring

It is not true that wire joints must be mechanically strong before soldering. This rule may have application in military and aerospace construction, but few amateur and experimenter applications involve such extreme requirements of vibration resistance and reliability. For lab and other light-duty applications a solder-only joint is perfectly reliable. The lead is brought to and into the lug, connector, or whatever, arranged so that

Tin/Lead Mix	Melting Point
40/60	455 deg. F
50/50	412
60/40	371
63/37	361
62/36 + 2% silver	354

Fig. 9. Some easily available solder compositions, and their melting points. Addition of a little silver lowers melting point an extra 7 degrees F.

it will stay there without outside help, and it is soldered. If changes are indicated, the wire is easily pulled free as soon as the solder is remelted.

Acid-core solder deserves special mention. Its reputation is not a product of special mention. Its reputation is not a product of sales interests. The acid is corrosive in plumbing applications, and has no place in the electronics lab. Kit manufacturers void their guarantee for any gear exposed to acid core solder for this reason. Paste fluxes too, are at least very messy and sometimes corrosive. Do not use them.

The popularity of soldering guns seems to be a result of good advertising. There is certainly nothing to recommend them to the serious worker. They heat quickly, but waste time at each application of solder. Since there may be hundreds or thousands of joints in a large project, soldering guns do not save time. And because of the small mass of hot copper at the tip, guns must use high power to maintain soldering temperatures. A long application of the gun to a joint may result in temperature excursions several hundred degrees hotter than required. Guns are clumsy, too, and mechanically inefficient. If their popularity is not due to good advertising, another plausible explanation is a repressed cowboy urge in the gun addict.

Soldering irons traditionally run too hot. Some otherwise excellent irons are notable in this respect. Any iron may be tamed by providing its power through a variable resistance, an SCR controller, or a variac. The variac is preferable, since the iron can be overvolted for occasional heavy-duty applications. This does not seem to harm the iron, if not overdone.

Solder is a tin/lead alloy, melting at a lower temperature than either pure metal. The melting point depends upon the ratio of tin to lead, being lowest in the 63/37 mix (63%, 37% lead) sometimes called eutectic solder. Low melting points in electronics applications are very desirable, and sometimes a little silver is added to lower the melting point a little further. See **Fig. 9.** Low melting point solders are more expensive than the 50/50 or 40/60 alloys, but reduced temperatures and faster soldering minimize heat effects on fragile electronics components.

Insulation removal with a sharp knife is too slow for modern electronics work. There are many strippers on the market, and the more elaborate ones are complicated mechanical monstrosities completely unsuited for serious electronics applications. Maybe they are appropriate for wiring houses rapidly. Of the simpler tools, the nicest is Miller's Model 100 Stripper, which should be cut down to fit small spaces. The stripper is also available with a return spring, but the spring serves largely to reduce feel so you cannot tell if you are cutting insulation or wire. In many stores the spring variety is the only one available. The spring is easliy removed and discarded.

A pair of fingernail clippers may be converted into a convenient stripper by grinding or filing a careful notch square to the jaw. Cut in until a hole appears, just large enough to clear the wire as determined by trial. See **Fig. 10.** There is enough space for two or or three notches for different wire sizes. Don't try to put a notch in the middle because there is a metal post inside.

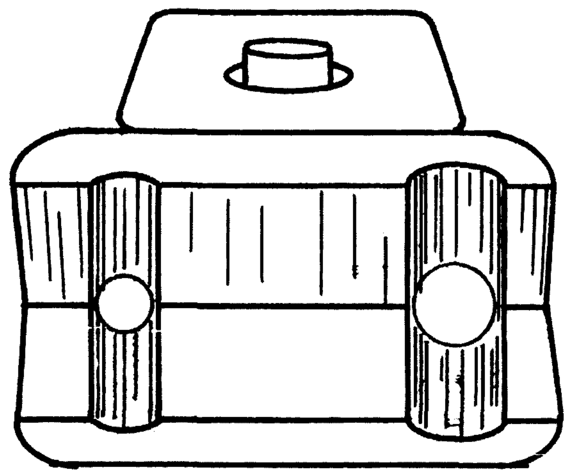


Fig. 10. How to notch a pair of fingernail clippers to make a handy wire stripper. A post through the center of the clippers will block a notch placed there, unless very short sections of insulation are to be removed.

The very best wire strippers are the thermal variety, which melt rather than cutting through the insulation before pulling off the unwanted end. These strippers do not score the wire, and cannot cut or notch it. Recommended for reliable applications. See catalogs near soldering irons. Oryx makes a nice stripper, which is listed in some of their catalogs.

In the matter of actually wiring a chassis, there is a lot to learn but not very much to say. Wiring goes in power wiring first, then miscellaneous innerstage and control wiring, and finally signal wiring. That puts the part that receives most attention on top. In the case of printed circuits, there is very little wiring, but some care is required to avoid a hazard of broken wires at board connections.

. . . W1EZT

Cheap *rf* Weatherstrip

A highly satisfactory substitue for *rf* weatherstrip may be made from common shielding braid. The garden variety sponge rubber weatherstrip found at your local hardware store is used to make it resilient. Surgical tubing filched from a friendly MD or nurse will also work well.

The mating surfaces of the crevice to be sealed are first drilled for small sheetmetal or machine screws. A length of braid is measured to fit the outline and a slightly shorter length of rubber inserted within this braid. The braid is then formed to the proper shape and the ends overlapped ¼" or so. Solder the braid together in one spot only. We don't want it to be so stiff that it won't conform to irregular surfaces.

Clean the areas involved with sandpaper or steelwool so as to present a good conductor. Put the seal in place and fasten the parts together. It is not necessary for the screws to go through the braid.

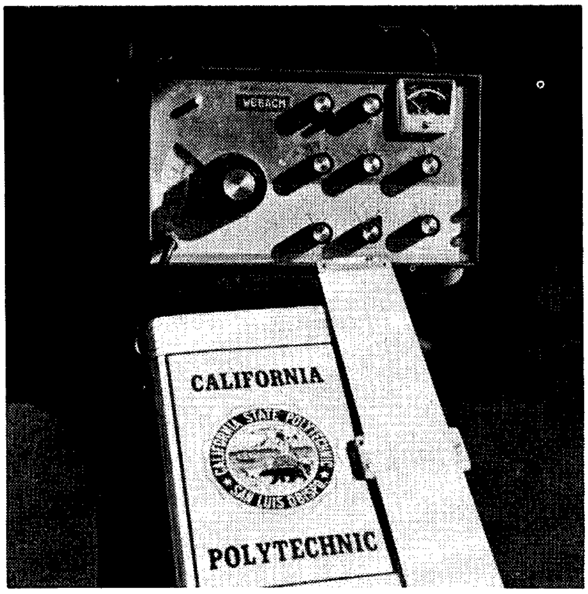
Various sizes of braid are commonly available at supply houses, I have found the ¼" and ½" sizes to be most practical. It is much easier to insert the rubber if the braid is first squeezed to the shortest possible length.

Seals between surfaces which already mate fairly well may be made without the benefit of the rubber insert.

William P. Turner WAØABI

Who Says You Can't Take It With You?

Joe Hannigan WB6ACM
887 *Isloy,* #3
San Luis Obispo, Ca. 93401



Schoolbooks, sliderule, and a mobile rig, all go toward making college interesting. Especially the mobile rig.

Amateur radio licenses are being earned by younger people every year. For those youngsters in a "ham family," having a license can be beneficial, because eventually they will be going to college.

Being away at college need not interrupt Junior's ham radio career. By planning ahead, his equipment can be selected so he can take it with him.

With the advent of the two and three car family, it can be supposed that he may have a car of his own. Consider the advantages of having a mobile installation.

Phone bills get awfully expensive in no time at all (remember the half hour phone call when you had your first fight with your room mate?); traveling to and from college would be more enjoyable with someone to talk to (plenty of people on 40 meters!); and besides, adventure is involved, and mobiling is just plain old fun!

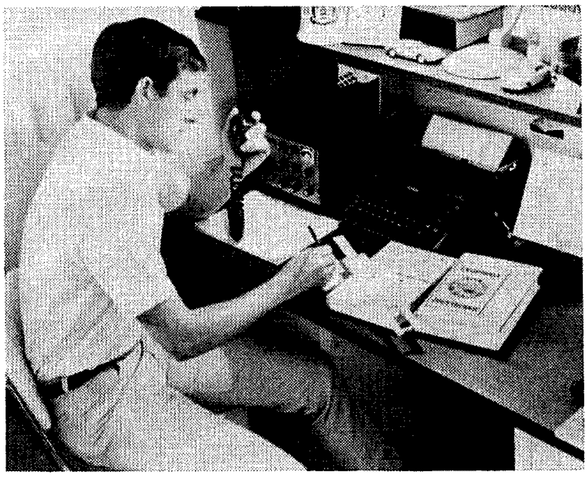
Since Junior may be changing residences during his college years, and ham radios aren't allowed in most college dorms, the obvious solution to keeping his license current is to put the rig in the car.

Several medium powered transceivers can be had for a nominal sum, and with a little ingenuity, some money can be saved by building your own mount or perhaps buying an easy-to-put-together kit.

Most transceivers have ac supplies available so they can be used indoors as a portable station. This can be handy if Junior decides to live by himself in a rented house or apartment. (Be sure to get the landlord's approval if you operate in an apartment house!)

The author selected a Galaxy III from the used gear market and got a New-tronics "Hustler" collapsible whip to go along with it, providing operation on 80, 40, and 20 meters.

A dc supply capable of handling the full 300 watts PEP of the Galaxy was purchased new, bringing the total cost to just over



The compactness of mobile transceivers allow them to be used right alongside the typewriter, taking up about as much space. The power supply is placed on the floor. Tired of studying? Take a QSO break.

A quick QSO on the way to classes makes the trip a pleasure. Plenty of time to work a few DX stations.

$300. An industrious young ham can earn this much in a Summer.

Instead of buying the commercially made mount for the transceiver, give a little thought to making your own. It's relatively simple to do, and all that's needed is an electric drill, a few feet of flat strap steel, and a few nuts and bolts. Let the junior op make the mount while the OM works a little DX.

The first contact the author made, after installing the Galaxy, was with Pennsylvania. Not too bad, but the second QSO was with New Zealand. And the third was Australia. Both signal reports from the South Pacific were S9 plus!

KC4USB in Little America (see "Operations Deep Freeze— 1957-1967," March 1968 73) gave the Galaxy an S5 rating. And Antarctica is about as far away as you can get from anywhere!

So if Junior is basically a DX man, he can continue his drive (no pun intended) towards DXCC with the mobile rig. And if he should encounter problems while crossing long deserted stretches of highway, he can always call for help. The West Coast Amateur Radio Service net is on 7.255 Mc, and they give priority to mobiles. Need help? Just call.

The young collegian will want to find a group of friends with similar interests, and he need look no further than the campus amateur radio club.

W6BHZ is the call of the Amateur Radio Club at California State Polytechnic College, San Luis Obispo, California. The author joined the club when he first got to school, and subsequently met JA8SB, whom he had QSO'd in 1962. Small world.

If you can't afford a mobile or portable station, then consider joining the campus amateur radio club.

Yes, mobiling may be the key to keeping Junior active while in college. If his date turns out to be a cold fish, he can always try to find a tantalizing Tahitian YL who's willing to QSO.

. . . WB6ABM

Frequency Allocations Chart

	PHONE ALLOCATION			CW ALLOCATION	
	Extra Class	Advanced Class	General Class	Extra Class	Advanced and General Class
Current	3.8 - 4.0	3.8 - 4.0	3.8 - 4.0	3.5 - 4.0	3.5 - 4.0
	7.2 - 7.3	7.2 - 7.3	7.2 - 7.3	7.0 - 7.3	7.0 - 7.3
	14.2 - 14.35	14.2 - 14.35	14.2 - 14.35	14.0 - 14.35	14.0 - 14.35
	21.25 - 21.45	21.25 - 21.45	21.25 - 21.45	21.0 - 21.45	21.0 - 21.45
	28.5 - 29.7	28.5 - 29.7	28.5 - 29.7	28.0 - 29.7	28.0 - 29.7
	50.1 - 54.0	50.1 - 54.0	50.1 - 54.0	50.0 - 54.0	50.0 - 54.0
November 22, 1968	3.8 - 4.0	3.825- 4.0	3.85 - 4.0	3.5 - 4.0	3.525 - 4.0
	7.2 - 7.3	7.2 - 7.3	7.225 - 7.3	7.0 - 7.3	7.025 - 7.3
	14.2 - 14.35	14.2 - 14.35	14.235 - 14.350	14.0 - 14.35	14.025 - 14.35
	21.25 - 21.45	21.275- 21.45	21.3 - 21.45	21.0 - 21.45	21.025 - 21.45
	28.5 - 29.7	28.5 - 29.7	28.5 - 29.7	28.0 - 29.7	28.0 - 29.7
	50.1 - 54.0	50.1 - 54.0	50.1 - 54.0	50.0 - 54.0	50.0 - 54.0 (A)
					50.1 - 54.0 (G)
November 22, 1969	3.8 - 4.0	3.825- 4.0	3.9 - 4.0	3.5 - 4.0	3.55 - 4.0
	7.2 - 7.3	7.2 - 7.3	7.25 - 7.3	7.0 - 7.3	7.05 - 7.3
	14.2 - 14.35	14.2 - 14.35	14.275 - 14.35	14.0 - 14.35	14.05 - 14.35
	21.25 - 21.45	21.275- 21.45	21.35 - 21.45	21.0 - 21.45	21.05 - 21.45
	28.5 - 29.7	28.5 - 29.7	28.5 - 29.7	28.0 - 29.7	28.0 - 29.7
	50.1 - 54.0	50.1 - 54.0	50.25 - 54.0	50.0 - 54.0	50.0 - 54.0 (A)
					50.25 - 54.0 (G)

The Thermistor

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An Electronic Device With Non-Electrical Applications

I remembered Ralph Hanna's article in the May, 1967 73, and when I was recently called upon to do a research paper, the thermistor came to my mind. Considering the electric characteristics of the thermistor, you might decide that it is a pretty dull animal, and leave your investigation at that. However, as I found out, there are some pretty unlikely and surprising applications of this device, as we shall seee. But first of all, we should find out what a thermistor really is.

General description

A thermistor is a semiconductor device with a negative temperature coefficient of resistance, opposite to most metals. The resistance follows an exponential variation with temperature which is given by the following relation:

$$R = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

R_0 is the resistance at T_0, and β is an experimental constant that can have a value between 3500 and 4500 degrees Kelvin. What this all means is that a graph like the one in **Fig. 1** will result. This shows how the resistance of a thermistor can vary with temperature; R is the resistance and T is the temperature. In practice it is best to determine this relation experimentally rather than try to depend upon mathematical calculations.

Physically, thermistors are made by compressing mixtures of compounds, usually oxides of manganese, cobalt, calcium, uranium, iron, zinc, titanium, aluminum, and magnesium. This starts out in a powder form, and the material can be formed into rods, beads, or discs, by a process called sintering. This is merely a process of forming a blob of material under high pressure and temperature.[2] Wire leads can be attached to the thermistor, and sometimes it is enclosed in an envelope of some kind, glass for example.

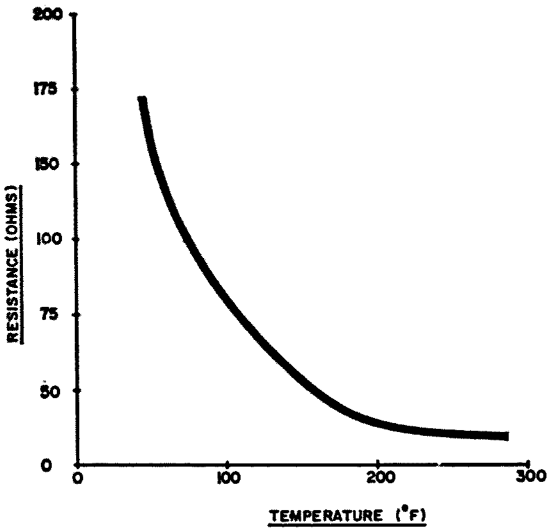

Fig. 1. Graph showing how resistance can vary with temperature.

General advantages and disadvantages

For all uses in general, thermistors have certain advantages and disadvantages over other devices. Advantages include small size 0.006 to 0.1 inch in diameter, and their low specific heat allows them to draw virtually no heat from the object being measured. Temperature differences as small as 0.0001 degrees F have been measured.[2] Their high resistance permits adequate impedance matching with associated equipment, and reduces effects of lead wire resistance changes on temperature readings.

This is not all for free, however, and we must be aware of a few disadvantages of using thermistors. One problem is the non-linear resistance–temperature relation which requires many calibration points, raising costs. When a thermistor is compared to a well made platinum resistance–temperature sensor, the thermistor will show poorer calibration stability. Another disadvantage

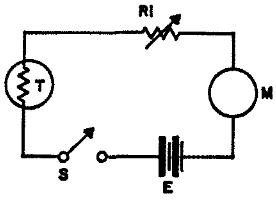

Fig. 2. Simple application of the thermistor. Current meter type of temperature measurement.

is that most thermistors of the oxide type show aging effects in that resistance increases with time. This problem can be solved by preaging which is accomplished by exposing the thermistor to a temperature that is higher than the temperature at which it is to be used. This will enable you to do very precise work. Also, enclosing the unit in glass will reduce chemical effects on aging.

A few uses and applications

R. F. Turner[3] lists and describes many applications for the thermistor, some of which seem rather unusual. First we shall discuss basic methods of measuring temperature, and later take a look at a flow meter and vacuum gauge that can be made with thermistors.

The biggest advantage of the thermistor in temperature measuring is remote electrical readout. If you would like to tell the operator on the other end of a QSO what the local temperature is without going outside, a thermistor thermometer is a great convenience. Similarly, if you would like to monitor the temperature in the final of your transmitter without opening it up and feeling around, then read on.

Fig. 2 shows the simplest application of the thermistor. T is the thermistor, E is a source of voltage, R_1 is the calibration control, and M is a milliammeter or microammeter. R_7 is set and the meter scale is calibrated in degrees. A well regulated constant voltage source is required, and a zener diode from Poly Paks, or some other low cost source will meet this requirement. Make the meter as sensitive as possible to limit the current flow in the thermistor because the thermistor will dissipate power just as any resistor will, and the heat resulting from this will effect the resistance. I noticed no problems of this type while using a fifty microamp meter, and this may be all that is necessary for your application.

Fig. 3 shows an ohmmeter measuring the resistance of the thermistor. This is the way that most experiments start. A chart can be made to relate meter reading to temperature, but this is not very convenient.

Fig. 4 shows the most commonly used circuit. R_1, R_2, R_3, and T make up a Wheatstone bridge. R_2, which is calibrated in degrees, is adjusted so that no current flows in the meter, and a very accurate reading can be made. This is not so convenient as just looking at a meter, but it is the best method for very precise measure-

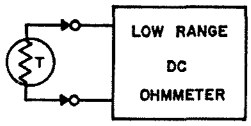

Fig. 3. The thermistor as a low current ohmmeter.

ments. I prefer the ordinary current meter method, first described, for my own uses, because it is very simple, and it works. None of these methods is beyond the ability of the average amateur and should provide interesting experiments, if you are looking for a gadget that is rather interesting, simple, and useful.

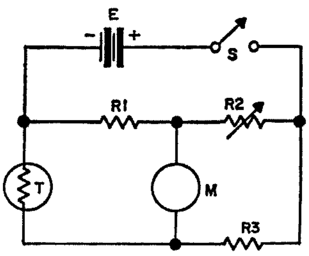

Fig. 4. Bridge type temperature measuring device.

Another device that can have applications for the amateur is a flow meter. **Fig. 5** from Turner shows a typical circuit of a flow meter that can be used to measure either liquid or gas flow. Heat will dissipate more rapidly from an object when it is in a flow than when it is in static surroundings. A bridge circuit is used to measure the difference in resistance between T_1 which is out of the flow, and T_2 which is out of the flow, but in the same medium. In this case the bridge is balanced initially with R_2, with the flow still. R_3 may have a scale calibrated in rate of flow. This method is much simpler than a mechanical method, is free from wear and vibration, and results in almost no pressure loss. Perhaps the more adventuresome experimenter could devise a

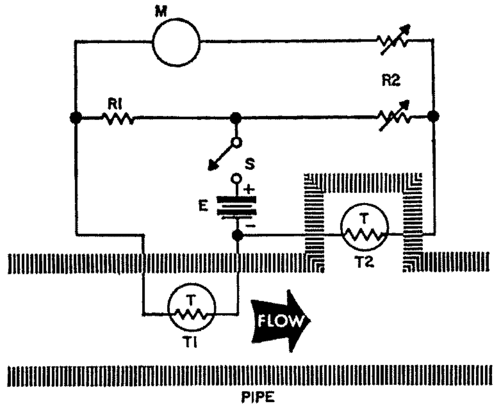

Fig. 5. Typical circuit of a flow meter to measure either liquid or gas flow.

method to monitor the cooling air flow to his 4CX250B's while at the same time measure their temperature.

As you might imagine, the ruggedness and low cost of the thermister allows it to be used where some of the mechanical counterparts could never go. Also, the convenience of electrical readout, recording and transmission of data allows us to sit comfortably in front of a control panel while taking measurements. So, the next time you discover a thermistor while rummaging through your junk box, pause for a moment and consider the many and varied applications that it can have.

. . . WB6BIH

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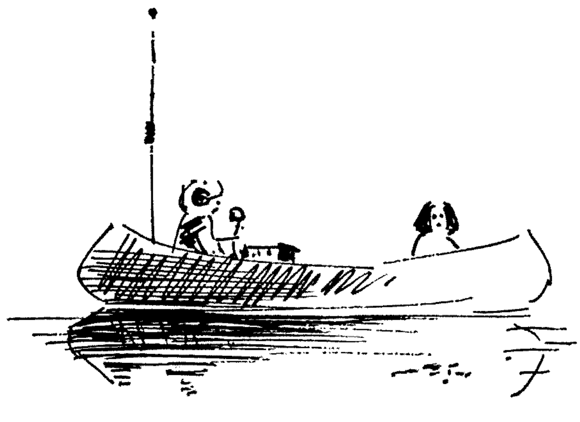

Printed Circuit Layout Template

After spending countless hours measuring the mounting centers required for the various components involved in laying out a printed circuit board, I decided to do something about it. I found a scrap of aluminum rack panel in my junkbox and converted it into a handy template. The plate I used was ⅛ thick and measured 3" by 9". On this area I laid out the mounting centers for ¼, ½, 1 and 2 watt resistors; single and dual low voltage electrolytics, disc ceramics; inline, triangle and diamond transistors; 7 and 9 pin tube sockets; and several types of small transistor transformers. Holes were then drilled to approximate the foil areas required and the plate marked with each component name.

Now, instead of measuring each component, I just slip it into the template holes to check for fit and transfer and dimension to the board or mockup. While not all components are listed, there are always usable holes. For example: top hat rectifiers fit the 1 watt resistor holes, while epoxy types fit the ½ watt holes. Note: Tube and transistor socket numbering should refer to the bottom view. There will be plenty of space remaining for future additions.

William P. Turner WAØABI

"I want something that will go well with news that I spent all the grocery money for a wide-band oscilloscope."

Using a SCR in a Teletype Series Wound Motor

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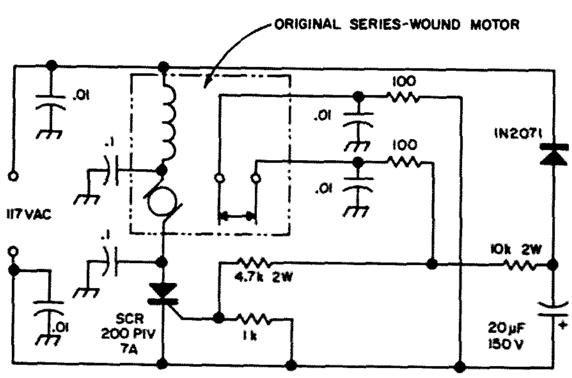


Fig. 1. Using a SCR in a teletype series wound motor.

In the interest of greatly reducing the spark and resulting interference from a motor that is commonly found in a Teletype machine, I used the circuit shown.

The resulting current across the governor contacts is reduced from about 1 amp down to about 10 mA. The noise that might be generated by this is completely inaudible now.

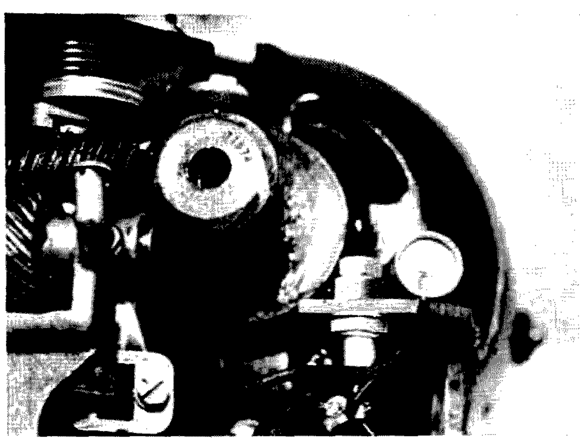
The SCR is one that I picked up at one of the mail order establishments advertised in "73".

When there is no voltage coming into the gate of the SCR, the motor speeds up. When there is a slight negative voltage coming into the gate, the motor then slows down. Using this theory, I then made up a little negative supply; the IN2071 and the 20 mfd/150 volt condenser. The output of this is then applied to a voltage divider consisting of 14.7 K (10 K and 4.7 K), and the 1 K resistor between the gate and the cathode of the SCR.

When the motor is either starting up or going too slowly, the governor contacts are closed, which makes the SCR receive no negative voltage, thus giving the motor more voltage. When the motor has attained its proper speed, the contacts open, and the SCR's gate receives a slight negative voltage, thereby decreasing the speed of the motor.

Though I experience no trouble with interference, you may find that you can further reduce any which may show up in your case by substituting small 2.5 mH chokes in place of the 100 ohm resistors. For the perfectionists, put an Ohmite Z-7 choke, bypassed to ground, in each lead coming out of the motor.

. . .W8NSO



Rear view of a model 14 teletype with the SCR mounted at the lower right. It is mounted on the small bakelite board with the condenser on the top.

The New Hi Voltage Transistors

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With the development of new transistor design and fabrication techniques, many good high voltage transistors have become available. In an attempt to improve transistors a compromise must be made between bandwidth and breakdown voltage. For high-frequency types the base region has been made thinner. Unfortunately this means we get low breakdown voltages (BVcbo, BVceo etc.). Only recently have high voltage, high frequency transistors been sold at experimenter prices. These units find application in line operated receivers, high power transformerless complementary symmetry (and quasi complementary) amplifiers and high voltage regulated power supplies. At the present time most high voltage units are NPN type (silicon). Below is a list I have compiled which shows some of the transistors being sold now. This list is not meant to be complete, only a guide and representative sampling. All units are NPN unless noted otherwise. Power dissipation is usually given at 25 degrees C. Above this temperature the transistor power dissipation must be derated. Where gain bandwidth product (f_t) is not given the transistor will usually be a low frequency unit. Prices may vary. Check your catalog.

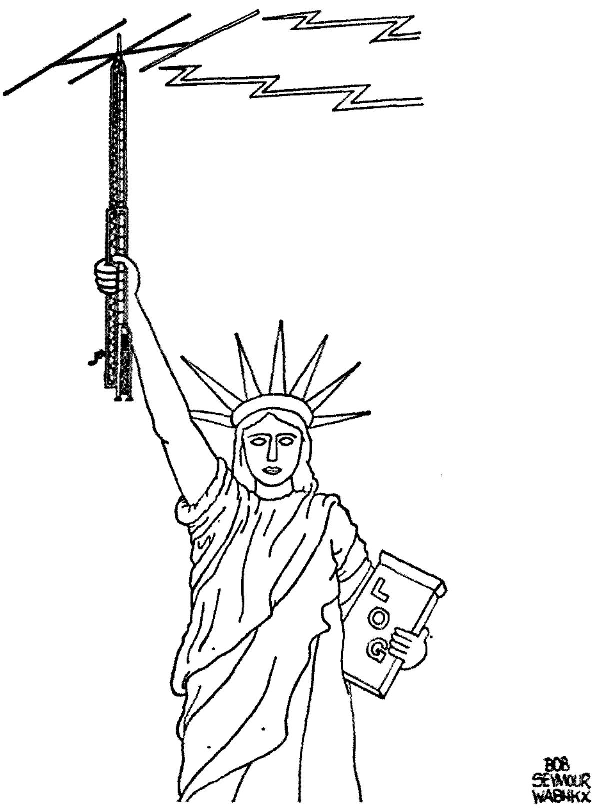
Index to manufacturers:

RCA	Radio Corp. of America
GE	General Electric
MOT	Motorola
MS	MS Transistor Corporation
TR	Transitron
RAY	Raytheon
STC	Silicon Transistor Corp.

transistor	BVcbo	f_t (mc)	power (w)	case	I_c (A)	price	mfr	type
2N3439	450	20	5	TO-5	1	3.71	RCA	
2N3441	160*		25	TO-66	3	2.89		
2N3583	250	10	15	TO-66	2	3.30		
2N3584	375	10	7.5	TO-66	2	6.60		
2N3585	500	10	5	TO-66	2	13.20		
2N3730	200		10	TO-3	3	1.24		PNP
2N3731	320		5	TO-3	10	1.62		PNP
2N3773	160		150	TO-3	30	7.84		
40313	300		35	TO-66	2	2.23		
40318	300		35	TO-66	2	2.10		
40321	300		5	TO-5	1	1.32		
40322	300		35	TO-66	2	2.15		
40327	300		5	TO-5	1	1.24		
40328	300		35	TO-66	2	2.18		
40408	90*	100	1	TO-5	0.7	1.08		
40409	90**	100	3	TO-5	0.7	1.14		
40410	90**	100	3	TO-5	0.7	1.64		PNP
40411	90**	0.8	150	TO-3	30	4.79		
40412	250**		10	TO-5	1	1.06		
40422	300	25	8	TO-66	0.150	1.03		
40423	300	25	3.8	TO-66	0.150	1.11		
40424	300	25	8	TO-66	0.150	0.98		
40425	300	25	4	TO-66	0.1	1.06		
40440	200		5	TO-66	10	1.32		PNP
40444	120	60	140	TO-3	20	14.55		

MJ420	275	30	2.5	TO-5	0.5	1.80	MOT
MJ421	350	30	2.5	TO-5	0.5	1.85	
MM2258	120	1.5	5	TO-5	0.5	3.90	
MM2259	175	1.5	5	TO-5	0.3	4.20	
MM2260	175	1.5	5	TO-5	0.3	4.50	
2N4054	300		4		0.1	1.56	GE
2N4055	250		4		0.1	1.44	
2N4056	200		4		0.1	1.20	
2N4057	150		4		0.1	1.08	
MST-20	200		2	TO-5			MS
MST-40	400		2	TO-5			
MST-60	600		2				
MST-80	800		2				
MST-100	1000		2				
DTS-413	400		75	TO-3	2	3.95	DELCO
DTS-423	400		100	TO-3	3.5	4.95	
2N1052	200	8	5	TO-5			TR
2N1053	180	8	5	TO-3			
2N1054	125	8	5	TO-5			
2N1055	100	3	0.15	TO-5			
2N1613B	120	60	1	TO-5		0.79	RAY
2N1711B	120	70	1	TO-5		1.65	
2N1893A	140	100	0.8	TO-5		2.45	
STT2400	150	25	10	TO-5	7.5		STC
STT2401	140	25	10	TO-5	7.5		
STT2403	120	25	10	TO-5	7.5		
STT2800	150	25	40	TO-59	7.5		
STT2802	140	25	40	TO-59	7.5		
STT2803	120	25	40	TO-59	7.5		

. . . K3VKC



Cord Untangler

You say you got the line cord tangled with your number nines and pulled the VTVM off the bench? You say you are having trouble plugging 11 cords in 4 outlets? Yes, Virginia, there is a way out.

Drop by your local TV parts emporium and buy out their stock of "cheater" receptacles. Install one on each piece of equipment. This should be done neatly, of course.

Naturally you have a supply of cheater cords liberated from defunct TVs. Plug one into each of several outlets and thereafter merely attach cords to the equipment currently *in* use. PRESTO! No cords to wind up, tangle, or generally get in the way.

I would like to take full credit for this high calibre idea, unfortunately KØRIR beat me to it.

P.S. Works great on projects too—the cord doesn't get in the way of redesign efforts.

William P. Turner WØABI

Project Facsimile Antarctic

. . . . . . Part II

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Winner's photo being posted on bulletin board. Official Navy photo

With the long dark Antarctic winter drawing to a close, plans were made with the men at McMurdo Station to hold a beauty contest as a final part of the morale operations of Project Facsimile Antarctic[1] for 1968. The only difference in this contest is that the girls would not be in the flesh at McMurdo Station but the selection of the winner would be made by facsimile pictures transmitted from the Project Facsimile Antarctic station WA6URW. The winner of the contest to be named "Miss Antarctica of 1969".

The Miss America Pageant officials in Atlantic City, N.J. were contacted and interested in assisting in this final morale offering. Pictures of the 1968 contestants of the Miss America Pageant were sent to the headquarters of Project Facsimile Antarctic and from there they were to be transmitted by facsimile to McMurdo Station. Through July and August, the pictures of the fifty contestants were transmitted with the vital statistics of each girl. A number was placed on each picture instead of giving the state of the contestant to avoid selection of a winner other than by beauty.

As the pictures were received at McMurdo Station, each one was hung on a large bulletin board in the mess hall. From the time that the first picture arrived until the last there was plenty of excitement at "chow" times when the men had elimination balloting to select at least ten semi-finalists. There were problems galore trying to select these ten semi-finalists as each group of men had their favorites. With pictures of fifty pretty girls and and two hundred and fifty Navymen, it was really going to be a tough job selecting a winner.

On the night of the final selection of Miss Antarctica, everyone was excited. There on the bulletin board were the pictures of ten semi-finalists, each one as pretty as the other. Once more balloting was started and it was touch and go until five of the contestants were eliminated. Now the big job was to select Miss Antarctica from five of the prettiest girls in the United States.

The hour was getting late but nobody thought of "hitting the sack" as they wanted

Casting the ballot to determine the winner of the "Miss Antarctica" title. Official Navy photo

a winner before this night was over. Again with balloting in 40 degree below zero weather, votes were tabulated and the selection was reduced to three finalists. Picking a winner was getting tougher and tougher but it had to be done. Once more the ballots were passed around and everyone took one more look at the pictures and the vital statistics (36-24-36) of each girl. This was to be the last ballot and one of these girls was going to be the winner, so each man was given plenty of time to make sure of his selection. The voting began and inside of thirty minutes a winner was selected. The tabulation of votes showed that Miss Rhode Island, a hazel eyed brunette, was selected as the winner of the Miss Antarctica Contest with Miss Florida as the first runner-up and Miss Colorado running third. At the time these selections were made, the men only knew these girls by the number on the pictures, but when they received the names of the states the girls came from, via radio, the mess hall at McMurdo was full of excitement. You can picture the men in certain groups boasting that they too came from the same state as Miss Antarctica. She was now their pinup girl.

At the Miss America Pageant in Atlantic City, Miss Rhode Island will be presented with a trophy inscribed as the first Miss Antarctica. Pictures will be taken of her at the pageant and, when received at Project Facsimile Antarctic headquarters, will be transmitted by facsimile to the Navymen at McMurdo Station so as to give them a final picture for the Miss Antarctica Beauty Contest.

With the Antarctic summer and the mail planes arriving shortly at McMurdo Station, Project Facsimile Antartic will have completed a successful morale operation for the "wintering over" Navy personnel who have been isolated, except for radio amateur phone patches and our facsimile operations, since March 1st, 1968. The officers and men at McMurdo Station have enjoyed receiving pictures of their families and participating in the beauty contest. Many are the "thanks" from these men and their families for the morale boost culminating from the operations of Project Facsimile Antarctic.

Although little used at present in amateur radio, facsimile has many interesting features to make it popular for those who like to experiment. . . .K6GKX

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Are You Really Ready for the Next Emergency?

On Wednesday, May 15th, several tornadoes swept across the midwest giving Amateur Radio another unsought opportunity to be of service. Twin tornadoes hit two Iowa cities almost at the same time. Charles City, Iowa came under attach at 4:47 P.M. and Oelwein, Iowa, 60 miles southeast, was nearly wiped off the landscape ten minutes later at 4:57 P.M. Each town had been hit by a different tornado and each funnel then squirmed on to wreck smaller communities of Elma, Maynard and a number of farms in two separate paths across the northeast corner of the State.

Five minutes after Charles City was hit Chuck Angel WAØINC, AREC director in Waterloo, Iowa, was busy alerting the local 2-meter FM network of amateurs. Several Waterloo mobile operators were soon headed, for Charles City, including KØCQH, WØDDW, WAØGZF, WAØINC, WAØIYT, WAØKZP and WAØUKK from Waverly, Iowa. When word flashed across 75-meters that Oelwein also had been hit, WØDDW, KØEDI and WAØFYG stopped short of Charles City and headed back southeast toward Oelwein, now further away than when they left their homes.

Have you ever wondered what you'd do in a similar situation? What equipment should you take? Where should you report and to whom? What is the first and most important communication service you can and should provide in such an emergency?

Perhaps a comparison of these two violent disasters, separated only by minutes and a few miles, will provide some of the answers and help you to be better prepared when it's your turn to act.

The first tornado, the one which hit Charles City, churned directly down Main Street wrecking most of the business section including several Public buildings, churches and schools, an 80-unit low-cost housing development and 150 square blocks of the town's residential area. All telephone and electrical lines were either torn down or cut off and the power company was wrecked. The water supply and gas supply was disabled and only a few places had portable generators which could be activated.

AREC Director Angel took his four Mobile Units to the Courthouse for instructions, then set up a communications system between the Courthouse, the Hospital and the National Guard Armory, leaving one unit free to go wherever needed most. With a number of dead already counted and several hundred injured awaiting discovery or waiting to be treated at the Hospital, the first and most important job for the Amateur operators was to call for Blood and for more Doctors, Nurses and Ambulances.

In a matter of minutes contact had been

made on 75-meters with Doc KØZZR, in Minneapolis and this Red Cross-affiliated station offered to obtain blood and a DC-3 to transport the blood to Charles City . . . If the airport of this 10,419 population town could handle such a plane . . . and IF the field could be lighted for a landing.

Off goes the spare Mobile Unit to find out and it didn't take long to radio back the good news that the airport had escaped the funnel-cloud. . .could handle a DC-3. . . and had its own lighting intact.

Next came an urgent call for drugs needed at the overcrowded Hospital and again 75-meters proved adequate (in spite of the QRN from the still-raging rain and windstorm). An operator in Dubuque, Iowa, WØYLS, offered to help. It took nearly an hour to decipher and relay the huge list of strangely-titled drugs in all that noise and confusion. Even so, within 3 hours after the storm hit Charles City, an airplane with the much-needed drugs was standing on the runway ready to take off as soon as clearance could be obtained.

Next came the order to assist the National Guard and local authorities who were trying to get things organized midst the terrible confusion which always prevails immediately after the sudden shock of disaster. ARED Director, Chuck Angel, hooked his all-band Transceiver to his small portable generator at the Courthouse, strung out a portable 75-meter dipole at 5-feet elevation and proceeded to act as NCS for the other Mobile units on-the-scene as well as dozens of Amateurs all over the country who were calling in, anxious to help get the traffic out during those early hours of the emergency.

Several hours later, after power had been restored in one part of the city, Charles City resident, KØYVU (Al) got his kilowatt SSB rig on-the-air and started the routine handling of incoming and outgoing health and welfare traffic which always comes too soon. Eventually, Al was joined by stations and operators from all over northern Iowa and southern Minnesota and nearly 1,000 messages were handled during the ensuing three days and nights.

Although 11 persons died in Charles City that night and more than 360 were injured, the death toll might easily have been greater had it not been for the quick response of those Waterloo Amateur Radio operators and the quick-thinking leadership of WAØINC.

Oelwein, Iowa, was a town of just 8,500 people but tornadoes play no favorites and a freak "three-funnelled" tornado formed at the southern outskirts of Oelwein, then swept right down Highway 150 through the main business district and on through 90 square blocks of residential area. Three people died instantly in Oelwein and two more were killed minutes later in Maynard, Iowa, as the triple-tongued tornado careened on toward the next town in its path. More than 300 additional residents of Oelwein were injured as the power company, telephone office, fire station, several churches and nearly all downtown buildings were severely damaged or completely flattened.

Local Police and the Highway Patrol had set up headquarters in the basement of the damaged Telephone Office when KØEDI and WØDDW arrived, having followed a bulldozer into the downtown area. While climbing over piles of brick, broken glass and boards full of sharp nails, we all wished we'd thought to wear heavy, hard-soled shoes. The town was totally dark except for the flashlights of searchers and the headlights and flashing red lights of emergency vehicles.

Neither KØEDI nor WØDDW had a portable generator but an Oelwein high school student, Burke Miller WAØPZR, soon borrowed his Dad's portable generator from a sign-company truck and managed to get his station on-the-air, using a make-shift antenna.

Lieutenant Kuch of the Highway Patrol sent the Mobile operators to the Hospital, located on the fringe of the most seriously damaged area, to determine what might be needed by the already overworked, doctors, nurses and other volunteers at the. Hospital. Fortunately, or unfortunately, this small three-story Hospital had been nearly full of patients before the storm struck so many of the most seriously injured tornado-victims had to be transported out of town to other hospitals in Independence and Waterloo, thirty miles away. No additional Doctors or Nurses were needed and the injured who remained at the Oelwein Hospital did not require any additional supply of either blood or drugs.

Hospital Supervisor, Sistor Mary Maureen, asked if the Amateur Operators could send

information to relatives of some of the injured, many of whom were visiting in the town or simply passing through when the tragedy came.

For nearly an hour WØDDW and WØFYG went from bed to bed (many of them hastily set up in hallways) gathering messages which the storm's casualties wanted sent to relatives in Oelwein or elsewhere around the country.

By the time the "local traffic" had been disposed of, more Waterloo amateurs arrived on the scene. WØEFM, Ev Frank and his wife, Kay WAØAOU, came equipped with a heavy-duty portable generator, a Transceiver and a full-size 75-meter antenna. KØDFH, KØDCV, WAØFYG and WØDDW helped Ev get the antenna connected to the top of a flagpole at the Red Cross Disaster Center, in the Sacred Heart Church, and soon WØEFM/Ø had begun a 74-hour continuous traffic-handling operation.

Although the hastily-erected antenna enabled WØEFM/Ø to communicate directly with stations from coast to coast it soon became apparent that an outside Net Control Station was a "must". KØLVB in Marshalltown seemed to have everything needed at the time. . . a good, strong signal plus the experience of an NCS on two SSB Traffic Nets in Iowa. Besides all this, Greg KØLVB had a personal interest in the Oelwein operation since his parents and two brothers lived there on the fringe of the most heavily-damaged area.

More than 560 outgoing and 490 incoming messages were passed through WØEFM/Ø between 0200Z May 16th and 0100Z the 19th of May (Saturday night). Two copies of each message were prepared as they were sent or received so the job of checking later would be easier. Local Citizen's Band operators set up a station alongside the Amateur station of WØEFM and volunteered their services in checking the "health and welfare" inquiries which by now were pouring in steadily.

During the first few hours several of the C-B operators provided a very important service and WØEFM/Ø was able to report the condition of several dozen families in the stricken area to stations "standing-by" on 3975 kHz. Soon, though, the CB volunteers ceased coming back for more traffic and for the next two and one-half days and three nights the amateurs were forced to seek the help of local high school students and additional mobile-equipped amateurs to run down the now-piled-up "Health and Welfare" inquiries. During all this time the CB Transceiver across the room continued to roar with the voices of dozens all screaming to be heard above the din of "Ten-Four". . . "What's your Ten-Twenty?", etc. . . as the sight-seeing began with the aid of an automatic "pass" into the restricted area. . . a Mobile Whip.

Some of the amateur operators were arrested on one occasion while attempting to obtain information about a family whose home was totally destroyed. No official "passes" had been issued and they were driving a car which had no Mobile antenna. The Officer told them to "Get back to the church or go to jail!" Ev Frank WØEFM, whose generator and radio equipment was providing the only communication to and from the town at the time, was ordered off the streets while travelling from one Red Cross shelter to another without a "pass". He had an antenna on his automobile but the rig was not in the car. It was pouring out messages from the Disaster Center.

WØEFM's portable generator provided the emergency power for station operation as well as lights for the Sacred Heart church basement where the Red Cross was busily caring for hundreds of volunteer workers and homeless victims each day. At least two amateur operators were busy manning the transmitter all day and all night. One could manage an hour or so of rest while the other worked along during the wee hours when message-handling slowed down, but it was difficult to sleep in the cold basement. The day of the storm had been an unusually hot Spring day but the cold front which produced the violent weather also brought a sudden drop of 40 degrees in temperature and no one had thought to bring along warm clothing, or blankets, or even a pillow to lean on for comfort.

By any measuring stick you'd care to use both the Charles City and Oelwein emergencies stand tall as monuments testifying to the dedicated responsibility for which America's radio amateurs are well known. As is usually the case, they were taken by surprise, caught off-guard, and not as well-prepared as we'd all like to be in such a situation. But, in both cases,

they did respond quickly. They handled the priority traffic first and they stumbled, however accidentally, into some of the prime necessities of emergency operation.

Naturally, your group will never face this same situation, regardless of the crisis which may arise in your area, because you're probably totally prepared. . . with a club-owned generator of adequate size, practice-sessions in connection with your AREC and RACES net-gatherings (as opposed to simple checking in and rag-chew afterward), Identification Cards for all Club Members, ready-made portable antennas complete with spare co-axial feedline, nylon rope, extra connectors, fully-equipped toolbox including a 12 volt soldering iron or two, extra microphones, stand-by transceiver, a well-established system of handling messages in an emergency. . . known to all or pre-printed so the instructions can be handed out to all participants at the scene of the emergency, an efficient system for alerting key-members of your group when the time comes, and most important of all . . .a definite plan for doing the whole job with amateur radio operators so you don't have to depend on any other group.

Just one more thing–if your Club can afford it, get yourselves a big, big sign which says:

"EMERGENCY COMMUNICATIONS
BY AMATEUR RADIO
OPERATORS. . . . . . . .HAMS!"

It's pretty sickening to pick up the papers your XYL saved for you to read after you'd been gone for three days and nights only to find a picture of a fellow "ham" in front of a TR-4 in the Disaster Center with a caption which reads:

"Citizen's Band Operator Provides Emergency Communications from the Disaster Area."

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Getting your Higher Class License

Part VIII — Transistor Principles

Just a little more than 20 years ago, a team of physicists at Bell Telephone Laboratories stuck some wires onto a solid crystal and came up with a device which acted like a cross between a transformer and a resisor—and which in the two decades which followed has revolutionized all phases of electronics.

Despite the widespread application of the transistor, however, its operation and use has been almost ignored in the FCC examinations up until the latest versions. The new Advanced Class exams include a number of questions on semiconductors, and this month's chapter of our Advanced-Class study course will concentrate on this area.

Only three of the questions in the official FCC study list for the new exams deal directly with semiconductors. These, which we will go into this time, are:

32. Power dissipation in what part of a transistor warrants careful observation of power ratings?
40. Compare transistors and tubes. What are the advantages and disadvantages of each?
46. What is the vacuum tube counterpart of (1) a grounded base circuit; (2) grounded emitter circuit; (3) grounded collector circuit?

Lest you think that three questions is too small a number to spend an entire installment on, read them again—and notice that two of the three require a rather comprehensive knowledge of transistor principles for adequate answers!

As we have done in the past, let's re-phrase the official questions into another group which can be examined in a more orderly sequence.

The first question in any dealings with a transistor must be "How does a transistor work?" You don't have to have a solid-state physicist's knowledge of the "how", but any use of the devices becomes much easier when you have some idea what's going on inside.

Almost all transistor specifications are given in terms of a "black-box analysis" which boils down to one of the three basic circuits listed in FCC question 46. That makes our second question for dissection become "What are the basic transistor circuits and how do they differ?"

An adequate comparison of transistors and tubes requires a knowledge of both the advantages of the transistor in relation to the more familiar tube. Our third question thus is "What are the transistor's advantages?" and the fourth is "What are its disadvantages?"

Finally, the power-rating question (No. 32 in the FCC list) is only one of a number of possible similar questions dealing with critical points in the application of transistors. To be prepared for all these questions, let's find out "What are the critical factors in using transistors?"

For those among you who *are* physicists, let's spell out in advance that this is a *practical* explanation of all these questions and as such, necessarily runs the risk of becoming oversimplified at some points. You aren't going to get very involved with "holes" or "minority carriers", and the matrix algebra so commonly encountered in any examination of transistor circuit approximations is going to be conspicuous by its absence. Many good books have already been written on solid-state physics, and we've studied quite a few of them in preparation for this article. But *this* article aims to give sufficient understanding of what goes on to satisfy the exam requirements, and possibly to whet interest in pursuing the details later.

Okay? Let's get on with it.

How Does a Transistor Work? Back in those dear dead days before semiconductors, most of us learned that vacuum tubes amplifying by deflecting and/or rejecting elec-

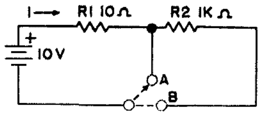

Fig. 1. This simple switching circuit shows the basis of transistor action; details are explained in the text.

trons in transit from cathode to plate, and that this action was brought about by the electrical charge on the tube's grid. The electrons were boiled off the cathode by the heat of the filament, and the tube had to have a vacuum because otherwise the grid couldn't accurately control the electron flow.

All of this is still true. So, how can a solid chunk of something very like sand do any amplifying when it has neither cathode, grid, nor plate, no vacuum in it, and no electric-charge effect worth talking about?

The answer is hinted at in the name of the device, which is a blend of "trans" meaning "through" and "resistor". The transistor is a special type of variable resistor, in which current injected (or withdrawn) from one terminal apparently goes "through" and affects current flow between the other two terminals. Incidentally, the familiar vacuum tube can be thought of in the same manner, as a variable resistor whose resistance is varied by grid voltage—and then the operating similarities between tubes and transistors become obvious. They operate in functionally the same way, except that transistors are operated by current while tubes operate by voltage.

Fig. 1 shows a simplified approximation of what a transistor does in a circuit. Placing the switch in position A, with the voltage and resistances shown, would cause one amp of current to flow through R1, with a resulting power dissipation of 10 watts. If, when we throw the switch to position B, we could keep that same one amp of current flowing through the circuit composed now of R1 and R2 in series, we would increase the power dissipation by a hundred times. This would be a form of power amplification—and in effect, this is what a transistor does.

The transistor consists of two adjacent junctions, between different types of semiconductor material known as "n" and "p" type. You can think of it as a thin slice of ham between two thick slices of bread if you like.

In a single junction, current can flow much more easily in one direction than in the other. When negative polarity is applied to the "n" side of the junction and positive to the "p" side, current flow is easy; when polarity is reversed, current flow is difficult and apparent resistance is high.

The "easy" current flow is a combination of two processes known as "injection" and "collection". The material on one side of the junction "injects" electrical charge into the junction region, and that on the other side of the junction "collects" this charge.

To get from one side of the junction to the other, the charge must "diffuse" through the junction region. In a single junction the diffusion will be either aided or hindered by the types of material involved and the polarity of the charge. This is what makes the current flow easy in one direction—when both materials aid the flow—and difficult in the other—when both oppose.

Such a single junction is widely used, for many purposes. The familiar crystal diode is one example of such a junction. The silicon power rectifier is another.

When we place the second junction adjacent to the first to turn the diode into a transistor, a number of additional happenings come into the picture. The basic processes of injection, diffusion, and collection remain the same. To obtain transistor action, though, one of the two junctions must be biased in the forward or easy-current direction while the other must be biased in the reverse or high-resistance direction. The single slab of material in the middle, which corresponds to the ham in the sandwich and is common to both junctions, controls the action.

Not all of the charge injected into this middle region or "base" by the forward-biased junction from the "emitter" material is collected by the base. Like the stream of electrons in the vacuum tube which flow past the grid to the plate, some of the injected charge passes right on through the base into the second reverse-biased junction. However, this charge is of the proper polarity to tend to forward-bias—or at least reduce the amount of reverse bias on—this second junction.

And when the amount of reverse bias is reduced, the resistance across this second junction reduces right along with it.

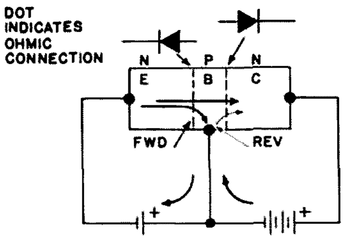

Fig. 2. Forward-biased emitter-base junction permits electron flow. Most electrons from emitter, however, pass right through the base region into the collector material, and this reduces the amount of reverse bias on the collector-base junction. The result is a variation of resistance in the collector circuit, which amounts to amplification.

In this manner, the current flow in the forward-biased base-emitter junction causes a reduction in resistance at the reverse biased collector-base junction.

If current injection in the base-emitter junction is increased by any means, the amount of charge which spills through the base to be collected at the collector-base junction will also increase. Similarly, if current in the base-emitter junction is reduced, the spill-through charge will also reduce.

Thus any variation of current in the base-emitter circuit will affect the resistance in the collector-base circuit as well.

Since current flows easily in the base-emitter circuit, this is a relatively low resistance circuit. Resistance in the collector-base circuit is much higher because of the reverse-biased junction. Because of the large ratio of the resistances in the two circuits, a small signal in the low-resistance circuit becomes a large signal in the high-resistance circuit—and we have amplification of the signal.

Fig. 2 shows how this action works in one of the three basic circuits—the common-base or "grounded base" arrangement. This circuit is of historical interest because it was the first to be used; most of today's applications use one of the other two circuits for several reasons.

As we have seen, the amplification in a transistor happens because of a difference in resistance between the input and output circuits, and the fact that the semiconductor material permits the current in the input circuit to affect the resistance of the output circuit.

It should be obvious at this point that the charge injected into the junction area from the emitter material divides between the base and the collector. While it might look as if most of the current flow would be in the base-emitter circuit and only a small part of it would be in the collector circuit, it doesn't work out quite that way. Most of the charge injected from the emitter passes right on through the base and is collected by the collector; only a small part is diverted by the base.

The ratio of collector current to emitter circuit is known as "alpha". Since the emitter current is the total of both the collector current and the base current, alpha is always less than 1. Just how much less is one of the major design features of any particular type of transistor, since alpha is the primary factor affecting the gain in any circuit. It is determined by the nature and relative sizes of the "n" and "p" materials which make up the semiconductor crystal. Early transistors had alpha factors in the neighborhood of 0.9; modern units range as high as 0.995.

This doesn't mean that the effective gain of a transistor must be less than 1 at all times. A more realistic measure of the effective gain provided by any one unit is the "beta" factor, which is the ratio of collector current to base current.

The "beta" and "alpha" factors are closely related. The closer alpha is to 1.0, the higher will be the beta. This is easiest to see by an example. Suppose we have a transistor hooked up in a circuit so that emitter current is 10 milliamps. If the alpha factor for this one particular transistor is 0.9, then the collector current will be 0.9 times 10 milliamps, or 9 mA. The base current will be the remaining 1 mA. The beta, however, being the ratio of collector to base current, will be 9/1 or merely 9.

If we put in another transistor and adjust the circuit to again have 10 mA in the emitter circuit, but find that the collector current is now 9.9 mA, then the alpha for the new transistor is 9.9/10.0 or 0.99. The remaining 0.1 mA is the base current, so beta is 9.9/0.1 or 99.

If we now try a third transistor with a known alpha of 0.995, we will find that for 10 mA of emitter current the collector current is 9.95 mA and the base current is only 0.05 mA. Beta, in this case, is 9.95/0.05, or 199. Transistors with beta ratings of 050 are not uncommon these days.

To relate alpha and beta by calculation takes only a small amount of arithmetic. Beta is equal to (alpha) divided by (1-

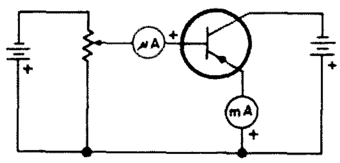

Fig. 3. Alpha factor of a transistor can be measured directly in this test set-up. Text explains technique.

alpha), while alpha is equal to (beta) divided by (beta +1). If you know either, the other can be easily determined by these relationships. Either or both can also be measured quite readily by the test setup shown in **Fig. 3.** It works exactly as our examples above were phrased; the transistor is connected and base bias adjusted for an emitter current of exactly 10 mA. The base current needed to produce this emitter current is then also measured, and subtracted from the emitter current to determine collector current accurately (beta of most modern units is so high that collector current cannot be measured with enough accuracy, directly). Beta is then calculated by dividing the collector current by the base current.

The inexpensive transistor testers so widely available use a simplified version of this scheme. Most of them use a battery and a large resistor to provide an approximately constant-current source of some 100 microamperes in the base circuit, and measure collector current with a meter calibrated directly in beta. If the base always gets 0.1 mA, then 1 mA on the meter represents a beta of 10, 2 mA is a beta of 20, and so forth. To check high-gain units, base current is reduced to around 10 microamps; 1 mA in the collector circuit then represents a beta of 100, 2 mA is 200, and so on.

Fig. 4 shows how this type of tester works. Despite its simplicity, it is as accurate as most tube testers.

Because the transistor works by a resistance relation, its input and output circuits are more closely connected to each other

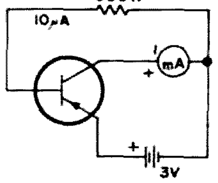

Fig. 4. This much simpler test circuit can read beta of a PNP transistor directly from meter. To use it with NPN units, reverse battery and meter polarities.

than are those of tubes. Alpha, beta, total circuit gain, and many other characteristics are affected by both the input and output components external to the transistor. We'll get into this deeper in the next question—the major point right now is that accurate prediction of how a transistor will perform in all possible circuits is not practical.

Because of this, the manufacturers rate them under a small set of rigidly specified input and output conditions. These are (1) input shorted and output open circuited; (2)both input and output shorted, (3) input open-circuited and output shorted, and

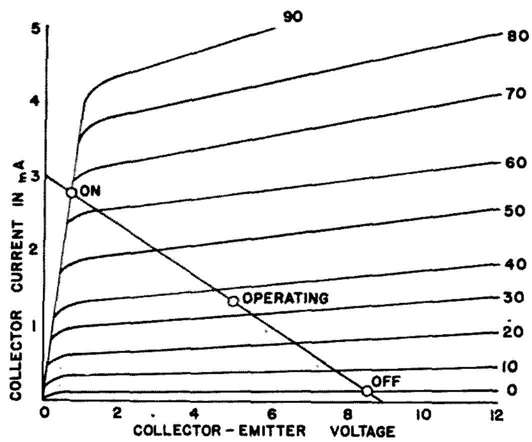

Fig. 5. Characteristic curve of a typical transistor is similar to that of a tube. Each curve in this family represents the collector voltage-collector current relationship for a single value of base current. Diagonal line is "load line" for 3000 ohm collector load resistor; Point labeled "operating" is bias point to operate as an amplifier with this load resistor. "On" and "Off" points illustrate switching action explained in the text.

(4) both input and output open. Of these, the first and third are most applicable to most circuits. The second applies only in a few special circuits, while the fourth is almost never used and can even destroy many types of transistors.

The characteristics of any particular type of transistor are measured under these specific conditions, and published as characteristic curves similar to those available for tubes. The conditions for each curve are always noted, but sometimes the notations are in engineeringese. **Fig. 5** shows a typical characteristic curve. These curves are used to predict transistor performance in the same way that tube curves are used to predict how a type of tube will perform in any planned circuit.

The curve in **Fig. 5** shows how gain is

affected by the amount of base bias supplied to the unit; the wider apart the horizontal lines are, the greater the beta and the higher the gain. With either too much or too little bias, gain falls off rapidly; operating conditions are rather critical.

With almost no bias, the gain falls to zero and current is virtually cut off. With excessive bias, the gain again falls to zero because the collector-base junction's resistance is as low as it can get. These two points, labelled "off" and "on" respectively in **Fig. 5**, are widely used in digital circuits—at these points, a transistor is a better switch than most ordinary switches. The TO keyer is a typical ham application of this type of circuit.

What Are The Basic Circuits? The transistor, as we have seen, is a gadget which can amplify—and as such it must have an input circuit and an output circuit. The gadget itself consists of three parts: the emitter, the base, and the collector. In most applications both the input and the output circuits work a "hot" signal lead against a "ground" connection so that the entire amplifier has only three signal terminals, which are "input", "output", and "ground" or "common".

This is not unique to transistors. With vacuum tubes we have the grounded-grid circuits and the cathode-follower or grounded-plate, as well as the conventional grounded-cathode arrangement.

Since the transistor has three internal components, we can choose any *one* of these three as the "common" or grounded element. This leads us to the three basic circuits for transistors—the common-emitter, common-collector (or emitter follower), and common-base (grounded base) circuits.

The word "grounded" is sometimes used to replace the compound adjective "common-" in the circuit names; the FCC study list uses "grounded" but most present writings appear to prefer the "common" phrasing.

Fig. 6 illustrates these three circuits, stripped to their basics. You can see that in every case, input signals are applied to the base-emitter circuit and output is taken off in the collector-base circuit—but the three circuits differ drastically in their characteristics because of the different ways in which they relate input and output circuits to each other.

For instance, in the common-base circuit shown in **Fig. 7** the input and output circuits are about as isolated from each other as it is possible to get with a transistor. The only point in the entire circuit at which both input and output currents are present is the transistor base (including its leads back to ground). The input circuit consists of the base-emitter junction and bias arrangement. The output circuit consists of the collector-base junction and its bias and load arrangements.

In this circuit, the input circuit sees a forward-biased junction and so exhibits very low impedance. The output circuit, on the other hand, contains a reverse-biased junction and so is of very high impedance. The circuit corresponds to the vacuum-tube grounded-grid amplifier, and offers the same advantages of high-frequency operation with good power gain.

The common-collector circuit shown in **Fig. 8**, on the other hand, makes the output circuit an integral part of the input circuit so that the output tends to completely "buck out" the input signal. The input circuit consists of the base-emitter junction, the load resistor in the emitter lead, and the power supply (with the common point passing through the power supply). The output circuit consists of the forward-biased base-emitter junction (which acts for it as a low-valued resistor), the base-collector junction, and the emitter load resistor.

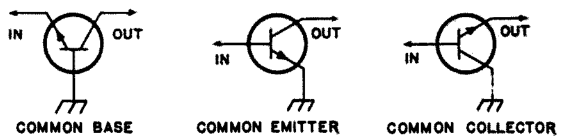

Fig. 6. The three basic transistor circuits are shown here. While all are related, characteristics of each differ from the others.

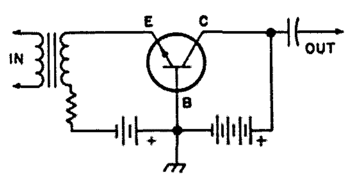

Fig. 7. Common base circuit was earliest. It has voltage gain, but no current gain. Input impedance is low and output impedance is high. Transformer input shown here can be replaced with coupling capacitor as in subsequent figures. Similarly, output load resistor can be replaced by transformer primary.

Since actual active input must be applied between base and emitter, while the output appears across the emitter resistor, the actual active input to the transistor in this circuit is much smaller than the applied input signal. In fact, the signal seen by the transistor is equal to the applied input signal *minus* the resulting output signal. If a 1-volt ac signal is applied and a 0.9-volt ac signal is produced at the output, the effective input to the transistor is only 0.1 volt and the transistor itself is performing at a gain of 9 although the circuit's gain is only 0.9.

With the effective input reduced by an amount proportional to the transistor's current gain (beta), the current flow in the input circuit is reduced by that same factor. Since we did nothing outside the circuit to reduce the applied input signal, this has the effect of multiplying the input impedance of the transistor by its beta and so the common-collector circuit has high input impedance.

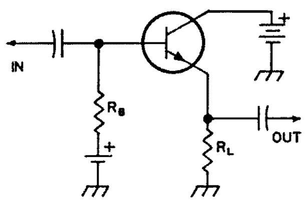

Fig. 8. This is common collector circuit. Both input and output current flows through load resistor R_L and the result is high input impedance, low output impedance. Voltage gain is less than 1, *but current gain can be high.*

The bucking-out action we have just examined affects *voltage* in the output circuit but does nothing to hold down the *current*. The output current is as great as our load resistor and operating point will permit, but the voltage associated with this current is reduced by the buck-out. This causes output impedance of the circuit to be divided by transistor beta; the result is very low output impedance.

The common-collector circuit, then, corresponds to the vacuum-tube cathode follower. It has high input impedance together with low output impedance, and voltage gain is always less than 1. With high-beta transistors, though, voltage gain can be almost up to 1. It will be, to a first approximation, equal to the transistor's alpha factor —which can exceed 0.995.

The remaining basic circuit is the com-

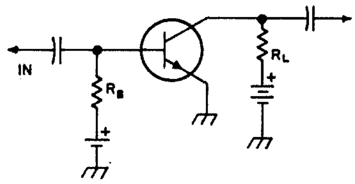

Fig. 9. Common-emitter circuit shown here is most widely used. It has both current and voltage gain, and so is only transistor circuit exhibiting appreciable power gain as well. Both input and output impedances are moderate.

mon-emitter arrangement shown in **Fig. 9.** This one acts in a manner midway between the other two. The input circuit—the base-emitter junction and its bias arrangement—is relatively unaffected by the output circuit, but in the output circuit the base-emitter junction is placed in series with the collector-base junction. This reduces output impedance by a bucking-out action, but the buck-out is much less than in the common-emitter since only a part of the output signal appears across the base-emitter junction while in the common-emitter the entire output signal appears in the input circuit.

The fraction of the output signal which does appear in the input circuit tends to increase the input impedance in much the same manner as in the common emitter. Again, the effect is much smaller.

Both the common base and the common collector circuits represent extremes—input /output isolation in one case and total interaction in the other. The common emitter circuit represents a compromise between these two extremes, and all its characteristics are intermediate between those of the other two. Voltage gain is moderate; not so high as in the common base but much higher than the common collector. Current gain, which is less than 1 in common base but almost equals beta in common collector, is also moderate. Since power is the product of voltage times current and the common emitter circuit is the only one in which both voltage and current gain exceed 1, it has the greatest power gain of the circuits.

Input/output isolation is only moderate in this circuit, which limits the frequency response and makes accidental feedback a possible problem. However, the common-emitter circuit, like the vacuum-tube grounded-cathode circuit to which it corresponds, is the most widely employed in practical applications because of its power gain

and preponderance of advantages over disadvantages.

You may have read elsewhere of the peculiar problems involved in adapting vacuum-tube circuits to transistors. Most of these problems are not inherent in transistors themselves, but are the product of the fact that the first transistor circuit used was the common base version. The same problems are present in grounded-grid vacuum-tube circuits—they're the problems of adapting one type of circuit to another type, not those of changing from one kind of component to another. The fabled "low impedance" of transistors, in particular, is apparent only in common base. With run-of-the-mill transistors, impedances equal to those of tubes can be obtained by proper blendings of the circuit types used. Common-collector circuits with high-gain transistors can have as much as 10 megohms input impedance; few vacuum tubes can stand that much grid resistance without developing "contact potential" bias problems!

What are the Transistor's Advantages? In the 20 years that transistors have been on the scene, they have virtually replaced vacuum tubes in many applications. Obviously, then, they must have some advantages over tubes. What are they?

The major advantages of the transistor as compared to the tube fall into three categores—size, power requirements, and reliability.

The size advantage enjoyed by the transistor is obvious to anyone. Typical transistor sizes are much smaller than those of tubes with comparable characteristics. The action of the transistor occurs within the atoms which make up a single crystal of semiconductor material—that of the tube occurs in a stream of electrons flowing from one physical element past another to a third. Today's integrated circuits were made possible by the transistor's capability of being reduced to truly microscopic size; the smallest tubes are still easily visible.

Power requirements for a transistor are much less than those for a tube of comparable abilities. The largest part of the power reduction comes about because the transistor needs no heater to make it work. Most tubes, also, require much higher operating voltages than do similar transistors, even though some tubes do operate at low voltages and some transistors are capable of operating at vacuum-tube voltage levels.

With no heater, the transistor also runs much cooler than does a tube. Even a power transistor normally is cooler to the touch than is an ordinary low-power tube. This reduction of heat in the circuit adds to the size advantage by permitting transistors to be packed into more compact spaces, and is in itself an advantage since no special cooling is required in many applications.

The most spectactular advantage, however, is in the area of reliability. A tube operates by boiling off electrons from its cathode. Eventually, the tube wears out and must be replaced. Even before this happens, the tube is likely to become gassy—or to be burned out or broken.

The transistor, on the other hand, operates by the injection of electrons into a crystal. No boil-off is involved, and there is nothing in the basic action to cause the device to ever wear out. The transistor *can* become contaminated, which corresponds to the tube going gassy, and it *can* be burned out—but if manufacture is controlled with enough care, contamination is not likely, and if the circuit is properly designed and operated, burnout is equally unlikely to occur. The result is that a transistorized circuit can be expected to perform properly for from 10 to 1000 times as long as a similar circuit using tubes.

So far as breakage is concerned, this is easy to demonstrate. Just put a tube and a transistor side by side at the edge of a table, and sweep both over the side onto the floor. After picking up the broken glass from the tube, test the transistor. It will probably be working perfectly.

The reliability of the transistor is what has made the digital computer industry, to cite but one example, possible. Premium tubes have a life expectancy of around 50,000 hours. If a circuit requires 100,000 tubes, the law of averages tells us that we can expect a burnout on the average of once every half-hour. This means that the longest period of operation we can expect from this complicated gadget is 30 minutes.

Similar quality transistors, however, have an estimated life expectancy of over 8,000,000 hours (the reason that it's estimated is that nobody has been able to run a test long enough yet to be sure that the figure is accurate). If those 100,000 tubes are replaced by transistors, then failure can be expected only once in 80 hours. The reliability of the device has been improved by

160 times—and any device that complicated can do any job expected of it in less than 80 hours.

While the figures may sound a bit extreme, many modern industrial devices contain tens of thousands of transistors. Such devices simply were not practical durihg days of tubes. This is, then, the major advantage enjoyed by the transistor.

What are the Disadvantages? We have seen that the transistor's advantages over the tube are primarily those of size, lower heat, less power required, and greater reliability. Why, then, have they not replaced all tubes?

Transistors do have some disadvantages. The greatest of these are in the area of high-frequency capability, and power handling. Both are being overcome, but it's a safe bet that in applications which involve both high power and high frequencies, tubes will be preferred for many years to come.

The first transistors were limited to low-frequency use. In fact, they did not perform adequately even over the audio-frequency range, and use at *rf* was impossible. The limit was pushed gradually higher until broadcast-band operation became practical —and kept going higher. Today, inexpensive transistors which perform nicely at 50 and 144 MHz are available. In fact, they outperform tubes at VHF frequencies today, having noise figures which are much lower than those of even premium tubes.

The first transistors, also, were limited to very low power. Even in the *af* region, they were unable to develop enough power to drive a loudspeaker. Like the quest for higher-frequency operation, the search for additional power moved forward. Audio power transistors became available, and some years later *rf* power transistors hit the scene. Today it's possible to build a 100-watt 6-meter transmitter using nothing but transistors.

However, the disadvantages are still present. That 100-watt transistorized transmitter is going to cost you more than would a kilowatt with tubes—and if you want a full gallon the tube is still the only practical choice at 6 meters. At any higher frequencies, the power capabilities are much less.

So, while it is *possible* to use transistors instead of tubes for power applications at *rf*, it's still much more expensive—and this is in itself a disadvantage.

There are some electrical disadvantages too. A transistor is, by its very nature, a voltage-variable capacitor as well. In high-frequency circuits, this capacitance can hamper action of the circuit. The transistor is a triode type of device, and so far it hasn't been practical to introduce elements which correspond to the tube's screen or suppressor grids. This prevents the transistor from being used in circuits which make use of these elements. Isolation between input and output circuits is much greater with tubes than with transistors.

Tubes are operated by voltage changes while transistors operate by current variations—and this means that a transistor must impose some load upon its input and output circuits while a tube can be made essentially a non-loading amplifier.

The net result is that, while the transistor's advantages make it the preferred choice for many types of uses, its disadvantages rule it out for many special applications.

What are the Critical Factors When Using Transistors? The basic differences between tubes and transistors come out most clearly when a designer attempts to put a transistor into a circuit. Because of these basic differences, transistor circuits have a number of critical factors which can be almost ignored when using tubes.

The two major critical factors are voltages and heat. The active area of a transistor may be no more than a few atoms in thickness. Since it is so thin, any applied voltage which is too high can cause "punch-through" which is similar to the puncturing of a capacitor. When punch-through happens, the result is a dead short at that point. Transistor action ceases and the device turns into a low-value resistor.

Punch-through can be either temporary or permanent, depending upon the power available at the puncture region. A temporary punch-through is of little consequence—as soon as the over-voltage is removed the problem is over. If, however, enough power is available, the transistor material is melted at the punched-through spot and the damage becomes permanent.

Since the material involved is so very small, it doesn't take much power to be "enough". A few milliwatts is more than adequate in most cases. For this reason, transistors should always be protected against over-voltage. The over-voltage may be in either the power supply or in the

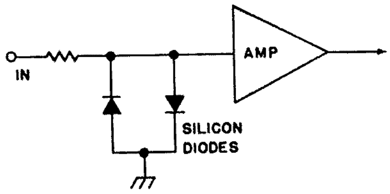

Fig. 10. *Amplifier can be protected against excessive input signal voltage as shown here. Diodes are essentially open circuits at voltages less than threshold (about ½ volt) and have no effect on small signals. Above the threshold, diode becomes short-circuited and cuts off overvoltage signal.*

signal circuits—a voltage peak in the applied signal is one of the most frequent causes for punch-through. The remedy is to incorporate voltage-limiting ahead of the transistor so that no input signal can exceed safe limits. **Fig. 10** shows such a safety feature; the parallel diodes limit input voltage to a maximum of half a volt and the rest of the amplifier is then designed to handle any voltage which can result from a half-volt input signal.

Over-voltage spikes on the power supply lines may be prevented by extensive decoupling, or by regulation of the power supply. A good battery is one of the best power sources since it is inherently regulated.

Heat is a critical factor for several reasons. If a transistor heats, its normal operating conditions are altered. The energy present as heat has the safe effect as an increase in input signal and power-supply voltages, and all characteristics change.

In addition, when the inside gets hot enough, the crystal structure which is basic to transistor action begins to melt and change. This change in the crystal structure destroys the transistor and turns it into a useless hunk of semiconductor material.

In fact, the damage done by over-voltage is actually done by the heat which results from the over-voltage condition.

Some heat is always present in a transistor, since it does its amplification by changing the resistance of the collector-base junction. Current is passing through this resistance, and whenever current passes through a resistance heat is generated.

This resistance is primarily in the collector-base junction, so that the heat of the junction is the primary factor. Transistors are rated for power capability on the basis of their ability to withstand this heat, and to carry the heat away from the junction as it is generated. Power transistors have larger collectors, which are designed to carry the heat away more rapidly—and to operate at their maximum power ratings even these must be connected to "heat sinks" which help carry the heat away.

If the heat generated in the collector-base junction is not carried away fast enough, it acts to change the transistor's internal operating conditions just as would an increase in applied voltage. More current flows—and the more current, the greater the heat. As heat increases, still more current can pass. The condition is known as "thermal runaway" and leads to rapid destruction of the transistor. Once a transistor enters the runaway condition, nothing can stop it until it is using all the current available to it or has melted itself.

When the junctions get hot enough, the base loses all control of operating conditions, this is the true "runaway" condition since no control is possible from the input circuit. The only control available is to prevent runaway from occurring.

The primary preventive measure we can use is to keep the transistor cool. This means using large enough heat sinks and assuring that enough air is available to keep the temperature within limits.

A secondary preventive measure is available by using an emitter resistor as shown in **Fig. 11.** Under normal operating conditions, the voltage appearing across the resistor is a part of the normal bias arrangement. When the transistor heats and "leakage" current (that current due to heat and not controlled by the base) increases, the voltage across the resistor increases and thus *subtracts* from the original bias voltage. This reduces the controlled current flow; if the reduction is sufficient, then heating will

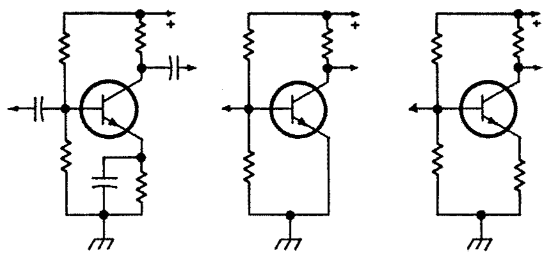

Fig. 11. *Use of emitter resistor to control runaway depends upon its effect on base-emitter junction bias. At far left is full circuit; at center is that part of the circuit seen by ac signals, while that part at right is effective to dc levels. Drop across emitter resistor increases as transistor heats, reducing bias and cutting down on dc current flow. This limits maximum current.*

be reduced and so will the leakage current. If, however, the runaway condition is reached, the reduction will have little effect upon the current.

The final preventive measure, which cannot be applied in many circuits, is to limit the amount of current available to the transistor so that it can never obtain enough current to melt itself under runaway conditions. Unfortunately, the circuits most likely to run away are those which must handle high power—and limiting the current also limits the power which can be produced by the circuit.

Any attempt to operate a transistor at a power level higher than that for which it is rated is almost certain to result in runaway. Additional heat sinks won't help, because a heat sink can only carry away the heat which gets to the outside of the transistor. If heat is produced *inside* faster than it can get out, then the junction itself will keep getting hotter and runaway will occur.

Most power transistors are rated under at least two conditions—without heat sink, and with "infinite" heat sinking. The first rating is usually identified in that manner; the second may be called "absolute maximum power". The first rating determines the power which may be applied to the transistor with no heat sink at all. The second tells us how fast the heat can get out; exceeding this second rating just about guarantees us a melted transistor.

Another factor involved in using transistors, which is less critical than the others, comes about because transistors come in two "flavors"—PNP and NPN—while tubes come in only one, which corresponds to the NPN transistor. The two types of transistors require supply voltages of opposite polarity. A PNP transistor requires that its collector be negative with respect to the base, and that the emitter be positive to the base, in order to operate. The NPN unit is just the reverse.

It's rather easy to apply wrong-polarity power to a transistor circuit; what happens then depends largely upon the circuit itself. If only one of the junctions gets the wrong polarity, the transistor may be instantly destroyed. If, however, both get reverse polarity the circuit may even operate after a fashion—but the actual collector will be serving as an emitter and vice versa. Some care should be taken when connecting power since it is possible to damage the transistors, but this danger has been overrated in the past. The reason for its emphasis in earlier days was that separate power supplies were usually used for input and output circuits, and if only the output circuit polarity should be reversed instant destruction was the result. Modern circuits usually use only one power source for all circuits, and reversing of that source normally causes no damage.

Next Month. Only a few questions remain to cover the FCC study list. Next time around we'll cover half of them, looking at power supplies, transmitter adjustment, and some find points of *rf* tube design. ■

RENEWAL CODE

The two numbers under your call on the address label are the expiration code. We have tried to make it simple. The first number is the month that we send you the last copy on your subscription and the second number is the year. 78 would be July 1968, for example.

Ipecac Works on Lids

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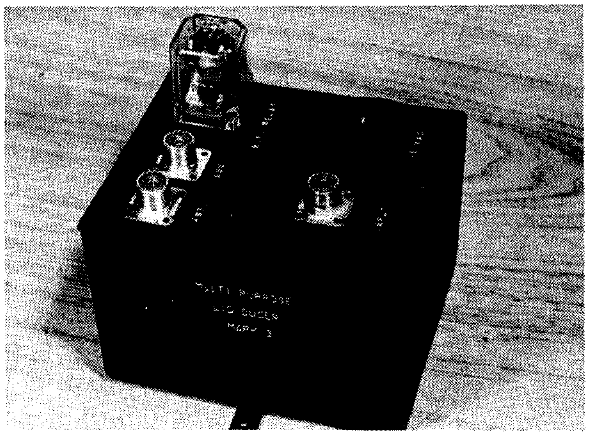
West Rye, N.H. 03891



Inside the cavern, the noise was deafening and minor skirmishes broke out from time to time between delegates. One teenage Extra class was severely skewered with a Hustler 20 meter mobile resonator deftly wielded by an irate Technician, who had taken issue with the youthful Extra for using his 6 meter halo as a basketball hoop. Although the auditorium sounded somewhat akin to 75 meters during sweepstakes weekend, the chairman did manage to restore a semblance of order. Using the normally oversized jawbone of a rag chewer (long since departed) as a gavel, he pounded on the skull of a Citizen Bander (the exact animate or inanimate state of this resoundingly hollow cranium could not immediately be determined. However, I assumed that its former owner too had long since departed this mortal soil, since its oral orifice remained motionless).

Calm, thusly restored, I found myself seated between a YN3 DX hound, who occasionally muttered, "CQ-DX," a Mexican BPL mumbling constantly about listing messages for Garcia and directly behind a WN2, who made several attempts to plug an 80 meter crystal into my nostrils.

I had, by default, been chosen to go to the Carlsbad Caverns to attend this, the first universal conclave of IPECAC (International Party for the Elimination of Cads and Acrimonious Cuckoos). The original delegate, an antenna experimenter, had been working on a remotely controlled sliding bazooka balun connected to a counterweight through a pulley. An unfortunate miscalculation caused the mechanism to misfire, dropping the counterweight which, because the experimenter neglected to let go, snatched him unceremoniously off his feet, up 54 feet of tower, through the 2" O.D. bazooka, and the even smaller pulley, then dropped him, 9 feet taller and considerably thinner, back to the cement base. His health is good, his bones are mending, but he was unable to attend due to a predictable difficulty in obtaining clothes to fit.

IPECAC is comprised of amateurs from all nations and all special interest groups and is dedicated to reducing or completely eliminating 'lids' and acts of lid-man-ship. For years it has been the considered opinion of these amateurs that 'lids' were not merely pests, but the largest problem facing amateur radio; larger even than the problem of the "SPONCH," that nasty subliminal creature, developed and nurtured by Vidiots (Video Idiots), who creeps up your mast and at that precise moment that you are, after years of patience and effort, about to make that all-important contact needed to complete W.A.C., W.A.S. or DXCC, sucks up all your radiated power. The "SPONCH" is the real cause behind the many laws not in effect pertaining to amateur radio that state, in effect, that the least desirable occurrence is most apt to happen at the least opportune moment. Oft times, the "SPONCH" will sit at the apex of your "V" gleefully waving a lightning rod during the one thunderstorm of the year when you forgot to ground your antennae.

While IPECAC is now universal, the originators—or founding fathers—came from a small group of net control stations who, in trying to work through QRM caused by 'lids,' had suffered some tangible harm. One common occupational hazard called, "Merging Ears" or "The Flounders" has claimed many a victim. It is caused by, over a period of time, increasing the tension between earphones and against the ears which gradually compresses the head. One such net control-

ler recently amazed a Ham gathering by revealing an uncanny ability to look through a keyhole with BOTH eyes; Another discovered that his nostrils were now wider apart than his eyes and one ill-fated YL, dressing up for an eye-ball QSO, was startled to learn that she could accommodate only ONE earring.

Besides this, and other, physical impairments resulting from contending with 'lids' there is usually a great deal of mental stress involved. Reactions differ, but a good example is that of one infuriated operator, who physically attacked his rig, driving a #2 phillips screwdriver straight through the plate meter—not only ruining the meter, but arc welding the T/R switch to the load capacitor and placing himself in distinct danger of being instantaneously burned to a cinder.

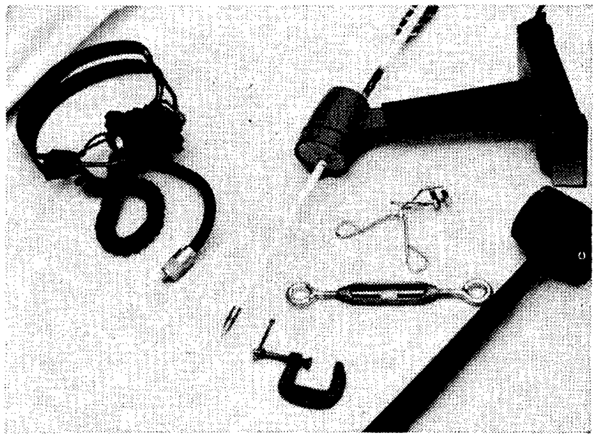
The straw that finally broke the camels back, however, and caused the unification of all anti-lids and the formation of IPECAC was the epic drama of a very well known and well liked ham. One afternoon, after battling lid after lid, he raced, in a fit of pique, into his yard armed with a double bladed axe and proceeded to chop down his antenna structure, forgetting momentarily that his equipment was VOX operated. When the structure finally came tumbling down, the ensuing thunderous clatter activated the VOX and the resulting RF output fused a 4 element quad, two yagis, a multiband inverted "V" and the operator together into one hopelessly tangled jumble of loose ended junk. The operator was transfixed in an anatomically impossible position at the center of a vortex of what appeared to be a stilted midget battling a horde of colossal aluminized praying mantis. Fortunately, Andy Wharhol happened along and affixed his signature to the mass. It is, as a lasting memorial and mute testimony epitomizing the need for lid elimination, now on display in a New York Op Art Gallery entitled, "Man and his orderly life plan."

Since, all too often, a member of one special interest group may erroneously label a member of another special interest group a 'lid' simply because their interests differ, one of the purposes of this conclave was to clarify exactly what a 'lid' was, and is.

A 'lid' (believed by many to be a contraction of **L**'il **ID**iot) can be simply defined as an operator who, intentionally or unintentionally, operates in a manner prejudicial to the enjoyment of others or conducts himself in a manner that projects an ungentlemanly – or poor ham – 'image' – in short, like the fella who smokes in bed, a lid is prone to make an ash of himself.

From all reports, lids are definitely on the increase, which precipitated the secondary mission of IPECAC—to find an alternative to the Wouff Hong. This instrument is too rarely used to prove a very effective deterrent, yet its occasional use renders it a ridiculous and purposeless outrage. For as it is now applied, the Wouff Hong is nothing but an arbitrary discrimination against an occasional, and most times, dim-witted victim.

Some members of IPECAC were thoughtful enough to bring along samples of their ingenius Wouff Hongs (see photo).



In the upper left hand corner is the Nordic /Germanic "SVENKA"—the earphones are connected directly to the *rf* output (a rather sneaky method of creating L.C.'s). The two screw type devices in the lower center are the "ANTI BUTTON PUSHING THUMB DISABLER" from Britain and the "WAGGING TONGUE LIMITER DINGUS" from Australia. The lower right hand corner contains the Russian "GRONSKY"—a heavy rubber mallet employed in, on, round and about the head and shoulders by a Neanderthal type from the upper Ural regions. Just right of center is the ingenious "PERUVIAN FINGERNAIL PINCHER"—and last is the somewhat crude, but highly effective, "PFFFFFFFT" used by almost all the Pygmy nations—it is sometimes dipped in curare for a "total" effect.

During the evenings, IPECAC members behaved as most conventioneers—squirting boutonniers—hand buzzers—bags of water off the stalagtites and the ever popular, "Girlie in the cake" who, in this instance,

burst out of an electrolyte cake, moulded n the form of the new FCC Headquarters, clad in two IRC coupons, a W1AW QSL card strategically placed, and various other items inherent to amateur radio. I guess I'm not much of a Stag Party man, because when she stepped on a glazed whipped cream figurine of Ben F. Waple, slipped and broke her "S" meter, I was secretly pleased.

There was only one real 'incident' during this skip distance revelry; one of the Russian certificate hunters came to the alcoholic conclusion that the olive in his martini was a concealed microphone and before anyone knew what was happening, he'd wired up a resonant Vic Tanny reject, worked 23 States, 3 Continents and placed second in the Fargo, North Dakota QSO Party.

In defining a 'lid' the IPECAC congress conceded that over 90% of all acts of lidmanship were perpetrated by 'good' amateurs in a moment of careless thoughtlessness and/or ignorance. This decision inspired the belief that gentle reminders would adequately replace the extreme applications of Wouff Hongs.

Consequently, a group of experimenters made up of three nationalities—Americans to conceive ideas, Russians to claim the ideas and Japanese to mass produce the item at ¼ of the cost while the other two groups argued—worked throughout the nighttime revelries to perfect what came to be known as the Lid Reducer—or "Lid-Ducer." —While the Mark #3 prototype "Lid-Ducer." shows promise, it is very loose in design and could stand some refining. However, the basic precept is sound and could/should become a standard incorporated feature in all amateur radio equipment.

When the Lid-Ducer was unveiled for IPECAC, most members wanted a practical demonstration. Volunteers were as rare as Rhode Island stations during a contest. A safari of scroungers (a common ethnic group among amateurs) was dispatched to recruit a volunteer. They returned with a 'jiggler'—you all know what a 'jiggler' is—he's the 8 handed fumble fingered jerk who invariably stumbles into your shack while you've got six hundred dollars worth of parts laid out on your bench and, despite repeated warnings, both oral and written, has an uncontrollable urge to jiggle a switch, fiddle

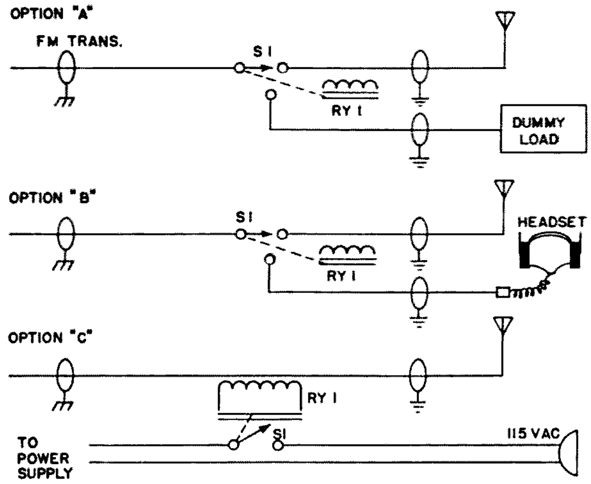


Fig. 1. *3 varieties of Lid Ducer.*

with a knob stretch a coil or juggle two 4CX-1000's. The safari laid an ingenious trap; they spread a table with knobs, probes, tubes and switches—then placed a 3 foot sign over the array reading, "DO NOT TOUCH UNDER ANY CIRCUMSTANCES!"—barely 5 minutes had passed before a shifty eyed, change jingling miscreant bumbled up, peered sneakily over his shoulder and jiggled a knob. This triggered a snare trap and they had their volunteer.

Because of a mass traumatic shock, the exact details of the demonstration are not clear in anyone's mind. We had selected the Nordic "SVENKA" option for the test. Unfortunately, the equipment used had a 'home brew' California amplifier which, unbeknownst to us, employed one hundred and thirty two 6146's in parallel. When the relay activated itself, all hell broke loose. The California kilowatt delivered full strength through the SVENKA not only zapping the volunteer, *rf* cooking his spleen, and performed an on-the-spot frontal lobotomy but the resulting pyrotechnics set off a chain reaction of UFO sight reports covering a three State area. In his mentally vacant and stagnated state, there was little else to do with the volunteer but send him to Foam Rubber City (Bonita, California) located somewhere between Oz, Disneyland and the Twilight Zone. We learned later that, with his newly acquired attribute of catatonic mindlessness, he was immediately scooped up and put to work eking out a meager living as the editorial chief of a block printed mimeographed ham pamphlet published in that city.

A photo and schematic of the Lid-Ducer, Mark #3 prototype and its three optional uses are shown elsewhere. It would, out of necessity, be a sealed unit when placed into equipment—but for the purpose of simplicity—it is illustrated as a separate unit.

The circuitry is cimplicity itself. The *rf* is normally coupled directly to the antenna. However, the relay is set to activate itself after 60 seconds of unmodulated or uninterrupted carrier is fed to the antenna. The relay can be programmed to react to almost any stimuli. The stimulus setting and timed reset delay can be preset at the factory and modified by the FCC as needed in lieu of issuing 'pink slips.' Once the stimulus activates RY1, S1 is thrown to the alternate position, which can either be coupled to a device similar to the Nordic SVENKA—possibly modified with an enema probe—or to a more conventional dummy load.

The Lid-Ducer should prove to be an effective reminder to that 90% of lids who are lids only because of a moment of thoughtlessness. Their punishment would be instantaneous and cost a minimum of 10 minutes of on-the-air time for each act of lid-man-ship.

One feature of IPECAC—an ultra extremist group—held out for more stringent measures—especially for that remaining 10% of 'lids' who perform lidmanship as an active avocation. They advocated 'the' ultimate weapon i.e., enforced listening to the 11 meter band for varying amounts of time depending upon the offense. Since we all know that no amateur of any repute could possibly endure more than a few minutes of this hideous torture without running, covered by microphones, amplifiers, 28 MHz crystals, pre-amps and squelch knobs, into the street screaming, "10-4 there, 10-4 there, wheeee—I'm the Eastern Mass Hunchback—I'm the Arkansas mugwump—and a whole bunch of 10-20's" this seemed to be not only an unjust, but inhumane punishment.

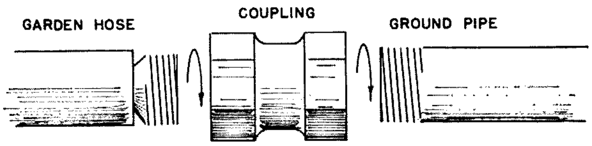
Unfortunately, before any further decisions could be reached, the meeting was brought to an untimely close when 2 MARS members and a CW man located an "OO" secreted behind some stalagmites surreptitiously listening on split phones to time ticks and loran signals while folding roadmaps and timing the speaches of various delegates. A mob formed, tied the "OO"

with a random length of RG58U and carried him from the cavern while he bellowed, "Long Live George Hart" and sang section 97.87 (in free verse) to the melody of "I Believe." They drove him off in an Edsel that, because of the cars design and the number of antennas attached to it, closely resembled a gigantic and quite recently goosed porcupine.

The next session of IPECAC is tentatively scheduled for the weekend of Arbor Day and is to be held in Atlantis. This will necessitate Maritime Mobile operation—section 97.97. applies. Entertainment thus far booked includes Senator Everett Dirkson giving his sterling rendition of The Communications Act of 1934 (in its entirety) and Jim Fisk tap dancing and doing the Frug to Conelrad signals.

. . . K1SYD

Instant Drilling Rig for Grounds



David B. Cameron WA4VQR
324 S. Riverhills Dr.
Temple Terrace, Fla. 33617

As most hams know, a good ground is necessary for safety and the effective use of some types of antenna systems. In some areas water pipes or the grounded side of power lines make good grounds, but in areas where these cannot be used the ham must install his own. Being a person of little brawn and even less desire to use it, I couldn't envision myself banging away on a metal rod John Henry style. I found, instead, a much easier and more effective way of drilling.

The gold and sulphur mines have been using the hydraulic method for years; I merely put it on a small scale. All that is needed in the way of parts is a large garden hose, a piece of ¾" iron pipe, which becomes the ground rod, and a coupling to connect the two. This is a special pipe to hose, female to female fitting. Any pumped source of water will do for power, but if you have a good sprinkler or well pump that you tie into, you may get more volume (if you have small pipes in your house, the house water supply may act like a high voltage power supply that drops when too much load is placed on it). Attach the hose to an outside sill cock or other outlet, link it to the pipe with the coupling (**Fig. 1**), punch the pipe through the grass, and turn the water on full blast (watch out for that first spurt, it's a lulu).

Keep some downward pressure on the pipe, but let the water do the work. It will dig quite rapidly in sand, as several inches a second, and somewhat slower in dirt or clay. The sand, dirt, and bits of rotted wood that come up around the pipe with the water are a constant monitor of the composition of your land at various depths.

If you hit a small rock, treasure chest, or other obstruction, give the water a chance to dig around it and then start punching at it with the pipe. If it is too large to move or break, you will have to stop there or try somewhere else. This will vary with the geology. A last note of warning: all that dirt had to come from somewhere. If all goes well you will only eat a hole about one inch in diameter and stopping off for a few minutes in one spot won't do much damage, so you can tell the XYL to quit worrying about the house disappearing. But if you get stuck at the one foot level for ten minutes with dirt still bubbling out, the next thing that you can expect to go down is the turf you're standing on!

. . . WA4VQR

Propagation Chart

NOVEMBER 1968

ISSUED SEPT. 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	7	7	7	7	7	7	14	21	21	21
ARGENTINA	21	14	14	14	7	14	21A	21A	21A	21A	21A	21A
AUSTRALIA	21A	14	14	7A	7B	7B	7B	14B	21	14	21A	28
CANAL ZONE	21	14	14	7	7	7	14A	28	28	28	28	28
ENGLAND	7	7	7	7	7	7A	14A	21A	21A	21	14A	14
HAWAII	21A	14	7B	7	7	7	7	7B	14	21A	28	28
INDIA	7	7	7B	7B	7B	7B	14A	21A	14	14	14	7B
JAPAN	14	14	7B	7B	7B	7	7	7	7B	7B	14	21A
MEXICO	21	14	7	7	7	7	14	21	21A	21A	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7	7	14B	14B	14	14B	14
PUERTO RICO	14	7	7	7	7	7	14A	21A	21A	21A	21A	21
SOUTH AFRICA	14	7B	7	7B	7B	14A	21A	28	28	28	21A	21
U. S. S. R.	7	7	7	7	7	7B	14A	21	21A	14	14	14
WEST COAST	21A	14	14	7	7	7	7	14A	21A	28	28	28

CENTRAL UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	14	14	7	7	7	7	7	14	21	21A	21A
ARGENTINA	21A	14	14	14	7	7	14	21A	21A	21A	21A	21A
AUSTRALIA	28	21A	14	14	7B	7B	7B	14B	21	14	21A	28
CANAL ZONE	21A	14	14	14	7	7	14	21A	28	28	28	28
ENGLAND	7	7	7	7	7	7	14	21	21A	21	14	14
HAWAII	28	21	14	7	7	7	7	7	14	21A	28	28
INDIA	14	14	7B	7B	7B	7B	7B	14	14	14	14	7B
JAPAN	21A	14	7B	7B	7	7	7	7	7B	7B	14	21A
MEXICO	21	14	7	7	7	7	7	14	21	21A	21A	21A
PHILIPPINES	21A	14	7B	7B	7B	7	7	7	14B	14	14	21
PUERTO RICO	21	14	7	7	7	7	14	21A	28	28	28	28
SOUTH AFRICA	14	7B	7	7B	7B	7B	14A	21A	28	28	28	21A
U. S. S. R.	7B	7	7	7	7	7B	7B	14	21	14	14	14

WESTERN UNITED STATES TO:

GMT -	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21A	21	14	7	7	7	7	7	14	21	21	21A
ARGENTINA	21	21	14	14	14	7	7	14A	21A	21A	21A	21A
AUSTRALIA	28	28	21A	14	14	14	7A	7B	14A	14	21A	28
CANAL ZONE	28	21	14	14	14	7	7	14A	21A	28	28	28
ENGLAND	7B	7	7	7	7	7B	7B	14	14A	21	14A	14
HAWAII	28	28	21	14	14	7A	7A	7	14A	28	28	28
INDIA	14	21	14	7B	7B	7B	7B	7B	14	14	14	7
JAPAN	21A	21	14	7B	7	7	7	7	7	7B	14	21A
MEXICO	21A	14	7	7	7	7	7	14	21A	21A	21A	28
PHILIPPINES	21A	21A	14	7B	7B	7	7	7	14	14	14	21A
PUERTO RICO	21	14	14	7	7	7	7	14A	21A	28	28	28
SOUTH AFRICA	14	14B	7	7B	7B	7B	7B	14A	21A	21A	21A	21A
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14	14	14	14
EAST COAST	21A	14	14	7	7	7	7	14A	21A	28	28	28

A - Next higher freq. may be useful this period. B - Difficult circuit this period.

Good: 1, 2, 4-6, 9-12, 14, 16-18, 23-25, 27-30
Fair: 3, 8, 13, 15, 21, 22, 26
Poor: 7, 19, 20

A Report on the WTW

DX activity during the months of July and August I suppose is at its lowest ebb, or at least this is indicated by the reports I have received here recently. Many WTW-Tally sheets have been sent out so I assume the boys are "getting ready" for the Fall season which is just around the corner.

I have hopes that right after the first of the coming year (1969) I will be at some good DX spots to give those needing certain countries on certain bands some assistance. Looks like another DXpedition is in the works now, had a good eye-ball QSO with Ack-W4ECI over in Birmingham, Alabama and Ack says—"If there is enough interest, we will do it again" (Ack was formerly the man back in the States who did all theorganization work, handling QSL's, etc.—on one of my DXpeditions and if I go again he will be the one to do this work. —He wants those interested to write him and tell him what they think) So fellows I strongly suggest that each of you get all your antennas in good working order and on all bands—from 160 through 10 meters, because I will be using all of them. I have an idea you will see some fellows qualifying for WTW on each band (6 bands actually) before this one is all over with this time. Before the real cold WX hits you get those antennas up so you won't have to face the elements when I get going—We hope possibly right after the first of the coming year. We are talking about some "big plans" for this DXpedition.

Only two have qualified for WTW since the last report.

WTW-100, 14MHz phone—W3SEJ received WTW certificate Nr. 58.

WT-100, 14MHz phone—W2NSG received WTW certificate Nr. 59.

Add to the honor roll listings the Call W4BYB with 151 countries on 7 MHz band CW. Also add to the 14 MHz listings 122 countries for WB2NSG—phone mode.

Please send me your claimed score for listing in the Honor Roll, would like to get your latest count for the gang to see. QSL's are not necessary, until you get up to the next WTW certificate, thats when we will want to see them. When you tell us you have 199 countries that's ok but when you get to 200 —we then want to see the cards!

There is no delay here in issuing certificates now, have a good file system working and your cards are returned pronto. I am sure all the various QSL check points can say the same.

Have received a number of letters from XE stations who are ready with their cards but are afraid to trust them in the mail—So we are looking for some good reliable Club in XE land to be our check point for QSL cards—any takers? The same goes for Europe, because I have heard from a few stations over there who tried out our European check point and I guess they have changed their mind—How about one of you good European clubs volunteering this little task for us?

Remember fellows send along with your application for WTW certificates $1.00 plus enough to return your cards via what-ever way you want them returned or else they will be returned by 3rd. class mail with the chance they may become lost along the way plus the delay in delivery involved. The best (at a reasonable rate, in my book) seems to be via "Certified mail". No need to insure them either way because my understanding is the fact that your cards have no value whatsoever to anyone except you, and if a value is placed on them in Dollars and Cents and they get lost—You will not receive anything.

Up to this time we have not issued any RTTY WTW certificates, so if any of you fellows Qualify for this band ship us your card and get the first RTTY WTW certificate. The same goes for bath 160 meters and 80 meters on either CW or phone.

Some of you new comers to DXing take my advice, "work all the DX you can now" because these superb conditions won't last too much longer. I understand the sun spot count has now passed its peak and when they get down low in a few years from now all this FB DX will not be heard at all. During these low sun spot times 10 may be stone dead, and many times 15 the same, 20 going dead at sundown, and even 40 meters may go out after midnight—maybe even 80 will do the same at times. So again I say—get in there and get the DX while you have the conditions with you like they are right now—The bands can get very very bad in a few years now.

I have plenty of WTW tally sheets on hand, 25c will bring you two sets of them. Drop me a line fellows—and don't forget send in your "claimed scores" for the WTW Honor Roll.

. . . W4BPD

Gus Browning W4BPD
Cordova, So. Carolina

Technical Aid Group

Please refer any questions of a technical nature to one of the following members of 73's Technical Aid Group. These are dedicated amateurs who really want to be of help and do so without compensation. Be sure to state your problem clearly and enclose a S.A.S.E. for a reply.

John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

Ira Kavaler, WA2ZIR, BSEE, 671 East 78 Street, Brooklyn, New York 11236. SSB transmitting, color TV, computer programming and systems, digital, radio and remote control, rf transmission lines, dipole design, audio amplifiers, linear and class C rf amplifiers.

Fred Moore, W3WZU, broadcast engineer, 4357 Buckfield Terrace, Trevose, Pa. 19047. Novice transmitters and receivers, HF and VHF antennas, VHF converters, receivers, AM, SSB, semiconductors, mobile test equipment, general, product data, pulse techniques, radio astronomy, bio-medical electronics.

Walter Simciak, W4HXP, BSEE, 1307 Baltimore Drive, Orlando, Florida 32810. AM, SSB, Novice transmitters and receivers, VHF converters, receivers, semiconductors, mobile, test-equipment, general.

James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

Douglas Jensen, W5OG/K4DAD, BA/BS, 706 Hwy 3 South, League City, Texas 77573. Digital techniques, digital and linear IC's and their applications.

Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland. Oregon 92705. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

Robert Scott, 3147 East Road, Grand Junction, Colorado 81501. Basic electronics, measurements. ■

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

that he is sick and needs immediate mental treatment and to leave this particular policing to the FCC. A bunch of "band police" with verbal billyclubs can clean out the band in short order, but if we let the fellows take their own time the results will be same in the long run and we will keep ham radio being fun and not a source of resentment and frustration.

Looking At The Editorials

Yes, I read the other magazines.

The September CQ editorial is still grumbling over the Electronic Industries Association proposals to the FCC, in a backhanded way calling them self-serving to the manufacturers. They seem to be overcritical of EIA, possibly because they were kicked out of the organization. The EIA has great possibilities for benefitting amateur radio. It is the first substantial effort to provide and coordinated channeling of the manufacturers in the ham industry. The EIA is doing a fine job in the CB field and I think we can look forward to similar progress in ham radio.

The one think that has been desperately needed for amateur radio for many years now, is a coordinated and extensive promotional effort. I have been writing about this for a long time now, trying to get the ARRL Directors to become aware of the importance of strengthening amateur radio through a recognition of it and a steady growth of our numbers. I haven't gotten very far with the League. They feel that there should be fewer amateurs and they are working to that end. The EIA believes amateur radio will be strong only if it is growing and is working on plans for our long needed PR campaign. Hooray.

Ham Radio magazine threatens that if you don't hurry up and start using our VHF and UHF bands that they most surely will be taken away. This is the old ARRL theme . . . threats. I wonder how many of us are moved by this argument to go to the trouble of getting on a VHF band? Hells bells, the threats of cancer have done little to slow down cigarette smoking and death by cancer is a lot more formidable than losing the 220 MHz band.

The threat to these bands is a real one, doubtless. But threats like this are just a waste of magazine space and the reader's time. If we want to get activity on the VHF bands we can do it. The magazines can encourage VHF operators to write articles tell-

ing everyone else how much fun they are having and giving circuits for easily built gear to get them on the bands. If Ham Radio or ARRL wants fellows to operate in these bands why don't they offer manufacturers half price or free ads for VHF equipment in order to encourage more companies to make gear for these bands?

The VHF bands are relatively vacant because our magazines have not done a selling job. A VHF column and an occasional construction article are not enough. If we want to move to the VHF bands we need PR for VHF. Tell me, what VHF awards are available from the ARRL?

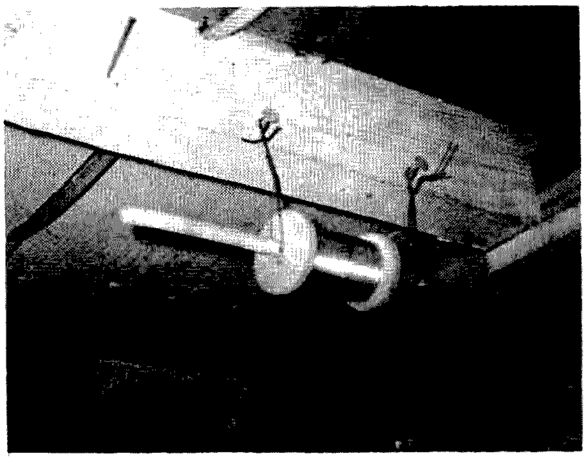
This gets back to my basic philosophy of getting people to do things by using the carrot instead of the nightstick. Ask them instead of telling them. Imagine how those years of going to school would have been if the schools had made them fun and enjoyable and you had gone there out of choice instead of being arrested if you didn't. School can be fun. Teachers can make learning enjoyable, but because they don't have to in order to attract students the whole process is a mess.

We will, hopefully, have some new ARRL Directors in office this fall and perhaps some of them will turn out to be more interested in the future of amateur radio than their own prestige of office and will buck the organized inertia at headquarters and get the League to spend some of that $1 million hoard on PR for amateur radio. We need a good experienced PR office to get ham stories into the newspapers, on the wire services, and into national magazines. We do plenty that could be publicized, but few people ever hear about it. We have some excellent ham authors and cartoonists that could be organized for the effort. One or two good articles in Playboy every year, the Saturday Post, Look, etc., and we would not only be known but we would find our radio clubs bursting with fellows eager to learn and become hams.

It is really up to you. You have to take it on your own self to get after your director and to get your friends after the director. Talk about this on the air and get everyone you talk with to call his director. It only costs a little to phone him at night and put the screws on him. A handful of phone calls to each director could change the future of our hobby.

. . . Wayne

The Solder Saver



Clifford Klinert, WB6BIH
520 Division Street
National City, Calif. 92050

Soldering is still the most commonly used method of connecting electronic components, and can be a source of frustration for any electronics experimenter or builder. Aside from the problems involved with cold and dirty solder joints that are encountered in learning the art of soldering, one problem is still common to even some of the most professional and experienced builders—finding the solder. Many frustrating minutes can be lost while hunting for the roll of solder that had been placed on the workbench only a moment ago. This is especially annoying when the experimenter is just on the verge of a startling discovery or a victorious success in some phase of electronics. Is the solder hiding under the page of a book? Or has a component or piece of test equipment been inadvertently placed in front of the roll of solder?

In the interest of reducing frustration and maintaining sanity, the simple device that is described in this article has been developed. In this case, a solder dispenser has been constructed by using a short section of TV antenna element for a shaft, and suspending it from the ceiling of the workshop with two short pieces of wire. The wires are fastened to the ceiling with two nails and connected to the shaft by passing it through two holes in the tubing. A spool of solder can be placed on the shaft before mounting the completed assembly.

This idea works well with small size solder as is shown, and has also had good success with the larger sizes that are most commonly used with electronic wiring. The increased organization that this simple device has added to an already overcrowded workbench greatly increased the efficiency and reduced fatigue in electronic project construction. It can help you too!

. . .WB6BIH

CLUB SECRETARIES NOTE

Club members would do well to get their club secretaries to drop a line to 73 and ask for the special club subscription scheme that we have evolved. This plan not only saves each club member money, it also brings badly needed loot into the club treasury, if desired. Write: Club Finagle, 73 Magazine, Peter Boro Ugh, New Ham Shire 03458.

Wind Loading On Towers

Bob Eldridge VE7BS
805 *East 20th Avenue*
Vancouver 10 *B C*

The great enemy of towers is wind, and towers are rated in terms of the drag in pounds per square foot of surface area presented to the wind.

Cylindrical section structures produce less drag per square foot with a given speed of wind, so lighter material can be used. Flat strap structure produces about 50% more drag and angle iron about 16% more than flat strap. The figures used for calculation of wind drag are fairly simple:

Pressure on cylinder $P_c = .0026V^2$
Pressure on flat surface $P_f = .004V^2$
Pressure on angle surface $P_a = .00464V^2$
Where V is wind velocity in mph.

For example if you expect winds of up to 100 mph, then a tower of round section should be at least a "27 lb tower", of flat section a "40 lb tower", and of angle a "45 lb tower".

This does not include any allowance for ice. If you live in a location where you may get icing on the tower as well as high winds, you had better seek some expert advice on towers before you buy one—if one falls down you may have a lot more trouble than just the broken tower!

Incidentally, while talking about ice, it helps a lot to paint a tower black (and any "plumber's delight" antennas too). When the sun comes out the metal then soaks up the radiant heat from old King Sol and melts the ice from within.

Don't try to cut down too much on the real estate occupied by the guys. The closer you bring the anchors to the base of the tower the more strain you put on the tower, and the more downward pressure you exert on the base. A tall pole on a small roof has been known to go clean through the roof at the base in a high wind. . . . VE7BS

Please Use Your Zip Code When Writing 73

The Care and Feeding of a Ham Club—part V

More Money Talk

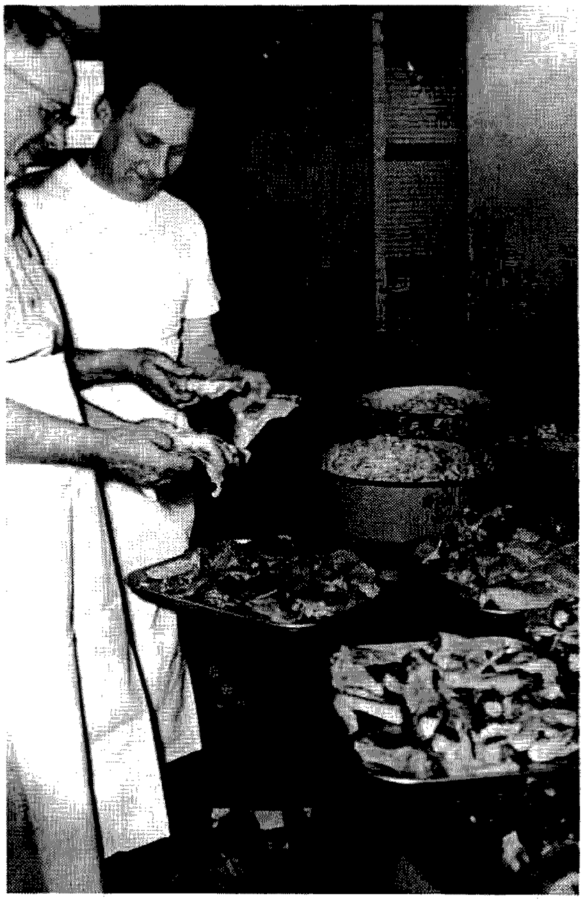
Carole Allen W5NQQ
308 Karen Drive
Lafayette, La. 70501

Sooner or later every club has to face the fact that dues and small donations just aren't enough to pick up the tab for a 50 foot tower, new rig, or generator. What then? Raise money, of course—but it's easier said than done. The first decision a club has to make is whether sufficient funds can be raised within the club by members making larger donations or if the public should be approached. The latter scheme, if properly handled, can do at least two jobs at once. If the club decides to tackle an interesting project, the result may well be a bulging budget as well as a more closely knit group.

A money-making project can be chosen from one of dozens of ideas and should be voted on by a majority of members. How about trying a bake sale with the ladies contributing cakes, pies, and other goodies? After the local health authorities issue the necessary certificate approving the sale of food, the pastries can be displayed in a downtown business place and sold to shoppers who are tempted and stop in. Since most of the food for a bake sale is donated, all but packaging expenses and perhaps rent for the window area will be clear profit.

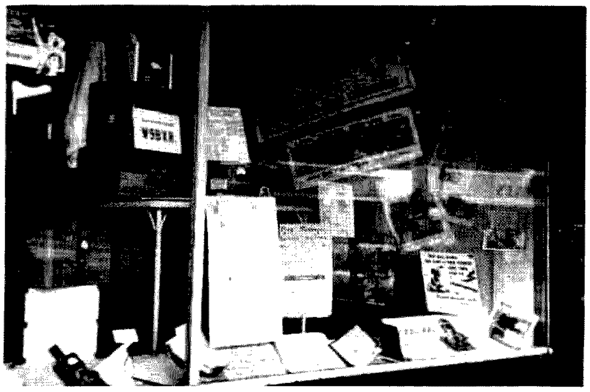
Although ice cream socials, chili and ham suppers, and public shrimp boils are major undertakings, they can be handled well by a large club with families that pitch in and work together. Naturally, a committee would have to be appointed with dozens of workers to plan the event, set up tables, prepare food, sell tickets, serve, clean-up, and perform the many behind-the-scene jobs.

As all super-salesman will agree, one of the secrets of selling is to give service to the public, and a community car-wash can be a big success. Check first with local officials to make sure no ordinances will be broken; then pick a likely spot (and con-



If the club needs more money than dues can provide, a special project will be needed. Here, the fellows pitch in to fry chicken and make cole slaw for a chicken dinner. If everybody in the club works together, money-making schemes can be fun as well as successful.

sider yourself lucky if you have a filling station owner in the club). The main expense will be the water bill and maybe a couple of chamois skins and sponges. A few large signs placed on the boulevard and some advance publicity will bring in enough cars to keep members busy washing and polishing. If a lot of hams pitch in, no one



A radio exhibit in an uptown store will draw a lot of public interest and may bring in some contributions for a worthwhile project if properly presented on posters. Shown is a window showing the activities of local amateurs.

will be too bushed at the end of the day. Campus clubs will find this idea a good one, for all that's needed is a spare Saturday, a sunny day, and some unharnessed energy.

If you live in a large city or a community that doesn't support car-washes, socials, and suppers, explore the possibility of getting help from a service organization. Many groups are always looking for a worthwhile project to sponsor, and since hams are known for their unselfish public service, their bid is almost certain to receive consideration and maybe approval. A service club might be approached for a generator, transmitter, or one certain piece of gear which can be named in their minutes and presented for a vote. The only hitch might be that a club member will be asked to present the plea in person and also to come back and give a radio demonstration about once a year, but who minds having a few strings attached to a big fat donation.

C. C. Kessler, K9SBP, of the Jersey County (Illinois) ARC says that although their club has very little expense, "We bought a large coffee maker and graveled the road to the shack after holding a White Elephant sale and selling candy we purchased on a wholesale arrangement."

Another possibility to look into is setting up exhibits at bazaars, fairs, homecomings and community celebrations. Nothing but a kissing booth attracts more attention than a ham radio display, so why not do a little soliciting at the same time? It doesn't hurt to ask, and if the town learns that their hams need help, contributions may come rolling in. But, look out if someone gets the bright idea that charging a less-than-

A bake sale with the ladies of the club donating the "goodies" is usually an excellent way to raise funds.

phone-toll fee for relaying greeting messages will fill the piggy bank, better remind 'em that the FCC just doesn't think it's cricket.

EXTRA, EXTRA, read all about it!

Not everyone does well "with pen in hand" or even wants to, and for this reason, editing the club newspaper can't be assigned to just any Tom, Dick, or Harry. Collecting material, writing, re-writing, and finally printing a paper takes a lot of work; and editors will tell you that they donate the hours involved as a labor of love.

Published to inform, remind, and entertain, a newspaper means just as much to a radio club as the Daily News to the city. And U.S. hams can be poppin' proud of many of their club publications. Outstanding with circulations in the hundreds are the *Auto-Call* printed by the Washington, D.C., area hams; the *SRA Bulletin* published by Spokane, Washington, amateurs; The Dallas, Texas *Monitor,* the Indiana Radio Club Council *Bison* and many others.

In addition to these major publications are countless small but top-notch papers such as the Montgomery County (Illinois) *Ham Hash* printed monthly with Bobbi Pattie, K9GOL, in charge.

"Our format is simple but varied," she commented. "The first page holds the heading, date, volume, number, etc., followed by last month's minutes which the secretary writes as to-the-point as possible. The Emergency Coordinator has a column of operating hints, ARRL bulletins, and sometimes a schematic for novices. The 2-meter net secretary submits "The Net Notes" which is a run-down of high frequency happenings, and another YL writes a scoop column

entitled "K-9 Barks and Remarks" covering local "gossip" such as new gear purchased, DX worked, hamfests attended, and you-name-it. I sort through this material, add some comments, jokes, and sayings, and then get ready to roll the presses."

The *Rams News*, formerly edited by Leon Nielsen, W6QHP, is a four-page paper distributed to the Radio Amateur Mobile Society of Sacramento, California. "We print features such as "RAM of the month," said Leon, "which is an entertaining biography of a new ham or veteran club member."

A run-down of picnics, parties, and transmitter hunts coming up is a popular feature and keeps everyone well-informed on what is planned, when and where. Another column known as "Glenn's Swap Shop" lists surplus gear for sale and the name of the OM who wants to sell it.

Another way to prepare in advance for "off-days," is to ask several club members to write a short column on "Why I Became a Ham" or some other provoking question. The columns can be made a monthly feature or filed away until editorial going gets rough.

After writing, editing, sorting, and assembling, the editor can't quit until the paper is printed, too. If your club has access to an off-set press or is lucky enough to have a professional printer in its ranks, that's great. The alternatives are mimeographs, hectographs, or a similar duplicating process that can be begged, borrowed, or bought inexpensively. Needless to say, the best machine the club can afford is none too good.

The best place for a new ham to find encouragement in getting his ticket and also learning to operate is in a club. Shown above is Brent Greenwood, K9RHL, getting tips from veteran Dale Stretch, W9KHQ.

The last step is distributing the monthly masterpiece, and this can be done in at least two ways. If the club owns an addressing machine or has some willing members who will address and stamp, papers can be mailed to everyone. Another method is to distribute copies at each meeting and then mailing them only to absentees.

Regardless of the way you write, print or distribute, and even if you don't win a Pulitzer prize, editing a newspaper provides a real feeling of accomplishment. And just in case you get the idea all the work isn't appreciated, just try skipping an issue some time.

The Radio Club as a Helping Hand!

"If it wasn't for the club," many a ham has said, "I wouldn't have my license today." A statement like this should be the goal of every group worth its weight in crystals.

Although a lot of cities offer courses in electronics in special schools and colleges, and a growing number of educators are putting radio and theory classes in their curricula, local clubs remain the best place for a novice to find encouragement and help in getting their tickets.

Needless to say, the ham who tackles teaching should know what he's talking about and also how to present the material and explain it clearly. Excellent teaching aids such as movies and film strips can be rented or purchased by the club and will be appreciated by both students and teachers. Another fine investment for the club is a code machine with a supply of tapes providing hours of perfect code. With this equipment on hand, a lot of veterans who feel the need to brush up at the key will sit on in the classes, too.

An excellent class project is group construction of a simple piece of gear such as a transmitter. Students will learn to handle tools, solder, and identify components. They'll also experience that wonderful feeling of putting something together. Here again, the club can save the day for the guy or gal who can't afford a kit or parts by financing the project for him.

Even after classes have closed and a new crop of novices have been licensed, the club still has a fine chance to be a friend in need. Transmitters and receivers don't grow on trees, and sometimes a ticket arrives be-

fore the rig does. A new ham and his family, too, will long remember the club station he borrowed for that first QSO. And if your members have a lot of surplus gear lying around, why not build up a low-power rig and receiver to loan to needy novices.

Local CW and Phone nets run by kind-hearted club members are excellent for knocking the rough operating edges off new hams. Correction from a friend who says "Don't talk so fast when you check in," or "Give your own call letters last not first" is hundred times easier to take than launching forth on the big wide ham bands and picking up the "Lid" label.

Club meetings themselves will aid both the novice and the technician through talks by experienced amateurs and bulletins including information on transmitter tuning and antenna adjustment. After the "new" has worn off the novice tickets, additional code and theory classes will get the fellows and gals started on their way toward the General Class license.

Last but not least, a new ham appreciates his club affiliation all over again when he stirs up that first nasty case of television interference. Stepping in with cool tempers and voices of experience, the TVI committee and a new ham's club membership never look so good. Like the chicken and the egg, it's hard to say whether the novice or the radio club came first, but who cares—they go together very well.

. . . W5NQQ

New Books

Basic Mathematics for Engineers by D. J. Hancox, South Birmingham Technical College, Edgbaston, Birmingham, England which was published by McGraw-Hill in England in 1966, is being made available for the first time in the United States beginning September.

This volume will serve as an invaluable reference for the engineer in his daily work, as a basic review for those who may have studied calculus sometime in the past, and as a helpful guide for anyone preparing for the professional engineering examinations.

The ten chapters of the book cover the following: Indices and logarithms—the laws of indices and logarithms transposition of formulae and natural logarithms; equations —quadratic and simultaneous equations, quadratic and linear with problems; determination of laws and graphical solutions of equations—graphs of linear, quadratic and cubic equations including circle ellipse and parabola, and examples of curve sketching; series—the arithmetic and geometric progressions, the binominal series for any index and the exponential series; trigonometry and mensuration—trigonometry summarized with identities and graphical problems; differentiation—from first principles, function of a function, product and quotient rules; application of differentiation—velocity and acceleration, rates of increase approximations and maxima and minima problems; integration—indefinite integration as reverse of differentiation as applied to algebraic, trigonometric, and exponential functions; application of integration—definite integration as applied to areas, volumes, mean values, root mean square values, variable forces, centroids (including Pappus Theorems), second moments of area; complex numbers—the Argand Diagram, addition, subtraction, and multiplication, and division of complex numbers. The slide rule and calculations are included as an appendix.

D. J. Hancox is a Senior Lecturer in the Department of Mechanical and Production Engineering at South Birmingham Technical College. He was formerly an aerodynamicist with A. V. Roe and Co.

Further information on *Basic Mathematics for Engineers* may be obtained from the McGraw-Hill Book Information Service, 327 West 41st Street, New York, New York 10036.

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Being a Novice is:

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Following the picture in the magazine instead of the schematic.

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Touching the terminals of your antenna switching knife switch.

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Mail from the ARRL every month asking you to enclose your dues in the *postcard* provided.

Finding out that that red lead *is* hot.

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David Colker WN31NL

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HAMMARLUND HQ-145C, calibrator, $110. Clegg Apollo 700-watt six-meter linear, excellent, $175. HamScan, $40. Ship collect. McCormack, 5008 Carlyn Spring, Arlington, Virginia 22203.

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PRINTED CIRCUIT BOARDS (less parts): Xtal controlled 15.75kHz, 60Hz, $4.50; 3.6V Power Supply, $2.50. Postpaid. Free list. Dirck Spicer, 11 Ridgeland Road, Wallingford, Conn. 06492.

GALAXY AC 400 supply $60, Speaker Console $14, Vibroplex Original $15, Turner 454X mike $11.50, W2AU Quad and 4:1 Balun $57. Write Ray Thompson, 337-52nd. St., Des Moines, Iowa 50312.

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1968 Cumulative Index

73 MAGAZINE

December 1968
Vol. XLVII No. 12

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Cover Photo: A collection of current Transceivers you might like to have Santa bring this year.

Editorial Statement: Any errors found in this magazine are put there deliberately. We try to publish something for everyone and some people merely read the magazine to find errors.

Contents

Departments

73 Magazine is published by 73, Inc., Peterborough, N.H. 03458. Subscription rate: $12.00 for Three years, $6.00 for one year. Second Class Postage paid at Peterborough, New Hampshire, and at additional mailing offices. Printed at Pontiac, Illinois, U.S. Postmasters, please send form 3579 to 73 Magazine, Peterborough, New Hampshire 03458.

Editorial Liberties

With this issue, I complete one year as editor of 73. It has been a very full year for me, and therefore has gone quickly.

Having given some serious thought to amateur radio from what might be considered a commercial view, I am becoming more and more impressed with facts. The 'magic' quality of ham radio simply doesn't exist any longer. Our image has changed, and certainly the role of ham radio has changed in the past years.

We (and I'm speaking of amateurs in general) developed the communications industry. "We" created the firsts in radio technology. Gradually, the ones with foresight began manufacturing radio equipment. They developed a better product than most of us could produce in the dim, dark, dank, dismal, buggy basement to which we were confined by the dictates of our spouses. And . . . we bought their products.

We are often confronted by the term "Appliance Operator," used in a derrogatory manner. Do we sneer at the housewife with her push button electric stove, her refrigerator, her modern zig-zag sewing machine. We use these appliances as they were designed to be used. We take advantage of the industry's ability to make a machine which will fill our needs.

Taking a look at other hobby magazines, does a photography magazine tell us how to build a camera? Does the sport car magazine tell us how to build an automobile? Do they tell the flyer how to build an airplane? The answer is, of course, no. They tell us how to *use* the equipment we have bought from a commercially organized company which produces the product we want.

Why is it that amateur radio must take the stand that if you don't build, you aren't really a ham. I firmly believe each ham should understand how his equipment works and be able to do maintenance. But I don't believe many of us could build a modern transceiver which would stack up to any of the commercial equipment available today.

Some hams get their kicks from building. Some read construction articles (even though they don't plan to build) the way others read Playboy. They complain that 73 doesn't have enough construction articles. Believe me, good construction articles are few and far between. With few exceptions, there isn't much new being built. I suspect, and hope, that ICs are going to spark a whole new era *in* building, but predictions are dangerous. Where does all this leave four magazines, which are, because of public opinion, devoted to construction? QST has no problem. They are blessed? with a large technical staff who can come up with a construction project. The other three have to fight for the good authors and resort to bribery to try to get their articles. Some you win, some you lose. I will continue to work to get the best people in the field to contribute construction articles as often as possible.

However, the appliance operator should not be looked upon with disdain. Having run the gamut of building and refining until our equipment has reached a point of sophistication which we cannot reproduce in the ham shack, isn't it time we learned to use it to its best advantage. Having built equipment which is designed for communication, shouldn't we learn the art of communicating? Listening to some of the idiotic stuff which goes on, I think we have a long way to go.

If what I hear from members of the industry is true, we may well have to begin building again. Going back to *Callbook* figures, they say we have roughly 290,000 hams in the U.S. By the time we eliminate the duplicates (those holding more than one call, or with expired calls remaining in print) and those who are inactive, we can cut that figure in half. When we eliminate the Novice (don't get mad kids) who doesn't spend much money on gear, we wind up with perhaps 100,000 potential buyers of amateur radio equipment. This is a generous estimate.

The manufacturer of a sophisticated transceiver has an initial investment of perhaps a half million dollars in the design of the equipment before it can actually go into production. The average ham buys a new rig about once in 5 years. So the total market, divided between all the manufacturers, is about 20,000 rigs per year. At an average expenditure of $1,000 per happy ham, divided between eight major manufacturers, the whole operation borders on charity. You may think, when you spend $500 on a new piece of equipment, that someone is getting

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de W2NSD/1

This UFO business is beginning to come out in the open a bit more and it is almost respectable to talk about them in many circles. It is interesting that there does not seem to be one single scientist who has carefully investigated the subject without becoming convinced that not only do the UFO's exist, but that they are extraterrestrial. If you have any friends who are still skeptical about UFO's you might suggest that they spend 6¢ and write to their Congressman and ask him to send them a copy of the House of Representatives Symposium on Unidentified Flying Objects, a Hearing before the Committee on Science and Astronautics on July 29, 1968.

The report should leave little room for disbelief in UFOs. Dr. James Harder, Associate Professor at UC Berkeley, says this: "Over the past 20 years a vast amount of evidence has been accumulating that bears on the existence of UFOs. Most of this is little known to the general public or to most scientists. But on the basis of the data and ordinary rules of evidence, as would be applied in the civil or criminal courts, the physical reality of UFOs has been proved beyond a reasonable doubt. With some effort we can accept this on an intellectual level, but find a difficulty in accepting it on an emotional level, in such a way that the facts give a feeling of reality. In this respect we might recall the attitude many of us have toward our own deaths: We accept the facts intellectually, but find it difficult to accept them emotionally." Dr. Harder suggests that the first thing that should be done toward further serious investigations of the UFO's is the establishment of an early-warning network. Since UFOs are frequently seen in the same area on succeeding nights he suggests that research teams set up immediately after a sighting with all of the instruments they can muster. He suggests that the Air Force provide transportation for the teams and their gear.

Dr. Baker of UCLA explained to the Symposium why most tracking radar is adjusted to ignore UFOs and why little is seen of them on our early-warning radars. He suggested changes in the radar systems which would permit them to sense UFO's and not just throw them out because they don't follow the missile trajectory pattern that the radars are set to watch for. It seems that there are hundreds of uncorrelated targets monthly which are not investigated at all because they are obviously not missiles.

It is interesting that UFOs are seen primarily by people who have not hitherto been believers in UFOs . . . though there is no record of anyone remaining a disbeliever after the experience. Of course only a very small percentage of the people who have seen them actually report their sighting. A recent poll indicates that about 5,000,000 people in the U.S. have ssen the UFOs so far, while there have been only about 12,000 filed reports.

Are UFOs spotted on radars? Yes, time after time . . . from land and air radars. Are they ever seen by large groups of people or are they almost always seen by isolated individuals? Frequently by groups and now and then by large groups. Three were seen flying across the airport at Longview, Washington during an Air Show, each from a different direction, about fifteen minutes apart. All three were seen by over 150 gawkers at the show when they were pointed out by the P.A. system announcer. All were seen clearly. Many airline pilots have seen them up fairly close, though few report them any more due to the jibes they get from other pilots and the company.

The hope of the scientists who gathered for the Congressional Symposium was that the "curtain of laughter" could be raised so that serious scientists could study UFOs and observers could more freely report on sightings. They also hope that a world-wide communications network can be established and that automated and instrument teams be set up to provide more information on UFOs.

Stanton Friedman, a physicist with Westinghouse Astronuclear Laboratory takes to task the few remaining critics of UFO reports such as Menzel and Klass saying, "I feel that these gentlemen have made strong attempts to make the data fit their hypotheses rather than trying to do the much

(*Turn to page* 70)

Robert A. Hirschfeld, W6DNS
Section Head, Communication Microcircuits
National Semiconductor Corporation
2950 San Ysidro Way
Santa Clara, Calif. 95051

Using the First Ham Integrated Circuit

Squelch, VOX, Speech Compression, and more, in a new Integrated Circuit designed with the Ham in mind!

For several years, 73 has been a leader in publishing articles on ham applications for currently available digital and analog IC's. Until now, however, no IC's had been produced specifically for two-way-radio use. At least one IC manufacturer, recognizing the need for such circuits, in the potentially large commercial, military, and amateur market, is now aiming a major development effort toward communication "subsystems on a chip", and it is expected that other manufacturers will follow. Besides the direct benefits of improved performance, decreased size, and lower component costs, which will reach amateur radio through commercially-built rigs, the new specialized chips will enable even the casual homebrew artist to construct sophisticated, complex equipment he might previously have considered beyond his reach.

The first Communication IC now available is the National Semiconductor LM270 Audio AGC/Squelch Amplifier. It is basically an operational amplifier, whose gain is controlled by a dc voltage, plus a built-in sensitive squelch threshold detector. The ten pin circuit replaces entire sections of today's transmitters, receivers, or transceivers, and makes speech compression, VOX, receiver squelch, and other functions practical in even the simplest homebrew rigs. While the chip contains 36 junction devices (transistors and diodes), and 20 resistors, it is size, rather than complexity which determines an IC's cost, so that the LM270, which is about the size of a single medium power transistor, is already cost competitive with the less complex discrete-component circuits it replaces. As volume commercial use of the circuit increases, the circuit is likely to be available at even more attractive prices.

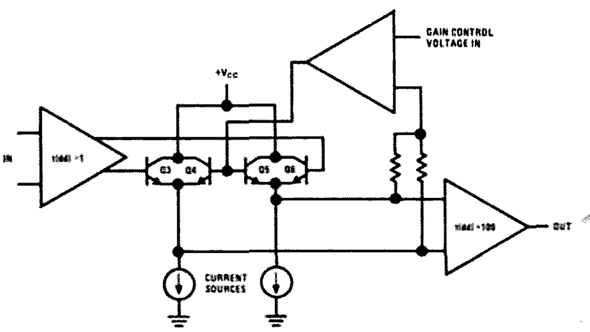

Fig. 1. Block diagram of variable gain amplifier.

Inside the can

The LM270 consists of several separate functions, designed to work together in a self-contained system, to produce control voltages for external use, or to respond to applied control signals. Heart of the circuit is a balanced series-shunt variable attenuator, formed by the four transistors in Fig. 1, which allows a large gain control range, with low distortion (for inputs less than 100 mV p-p), and which can be directly coupled to other parts of the system, eliminating the transformer or capacitor

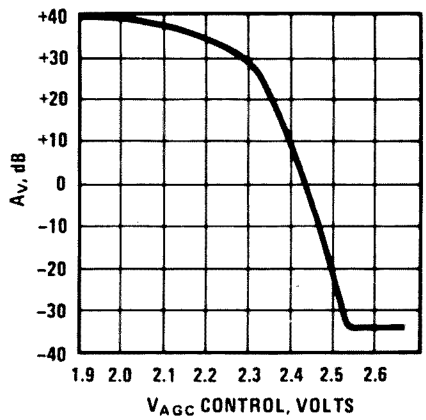

Fig. 2. Typical voltage gain vs. control voltage applied at pin 4.

coupling necessary with all other variable arrangements. From a twelve volt supply, the gain vs. control voltage relationship is a smooth curve, as in **Fig. 2**, which gives a constant gain of +40 db for control voltages between zero and +2 volts, and is effectively "shut off" above +2.6 volts.

A separate subsystem within the LM270 is the squelch detector, **Fig. 3.** Using the same input differential amplifier as the variable gain circuit, the high gain peak detector formed by Q20, Q36 and Q21 responds to very small inputs (as little as a millivolt, depending on setting of the external threshold pot), by rapidly discharging an external capacitor. In the absence of input signal, C(ext) charges above +2.6 V, which, when tied to the gain control input, keeps the output amplifier "off". A momentary input peak above the threshold causes Q21 to rapidly discharge C(ext) below +2 volts, turning the amplifier fully "on". This arrangement gives a fast attack, slow release squelch, which catches first speech syllables, and waits long enough to avoid "cutting out" between words.

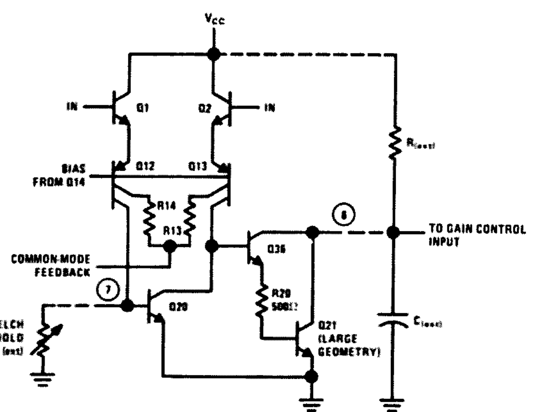

Fig. 3. Differential input circuit and squelch detector.

The complete circuit appears in **Fig. 4.** A detailed explanation of each part, too lengthy for inclusion here, may be found in the references.

Practical ham applications

Before going into specific circuits, a few general remarks are in order. Those familiar with operational amplifiers will easily recognize the LM270 configuration. Differential inputs allow inverting or non-inverting gain, or drive from a "floating" signal source. If single-ended drive is needed, the unused input is simply tied to the same reference voltage as is the actual input. All that is required is that both inputs be at equal dc potential, somewhere between +4.5 volts and the positive supply. Like an "op amp", the LM270's dc output voltage stays at approximately half of the positive supply voltage, for all supplies between +4.5 and +24 volts, so that symmetrical output clipping occurs.

Two identical gain control inputs, pins 3 and 4, are provided, which allows control by two independent sources at the same time, such as simultaneous AGC and squelch. By bypassing pin 2, the gain control inputs become emitter-follower positive peak detectors. The control inputs are protected by 6.5 volt zeners (Q33 and Q34). If the control input is expected to rise above +6.5 volts, a 10K series resistor at that input should be used to prevent excessive dissipation in the zeners.

Remote gain-controlled audio amplifier

A simple application is a preamplifier, **Fig. 5**, whose gain is manually controlled, noiselessly, by a dc voltage from a remote location, rather than running long, capacitive coax signal lines to and from that location. Pin 4 is bypassed by an external capacitor, to eliminate noise pickup. Since the gain-control curve, **Fig. 2**, is approximately logarithmic, a linear pot will give a desirable logarithmic audio attenuation characteristic.

For illustration, the second control input is shown connected to an IC logic gate, of the DTL, RTL or TTL varieties now available at low cost. This gate, operating from a five volt supply, can be part of a logic

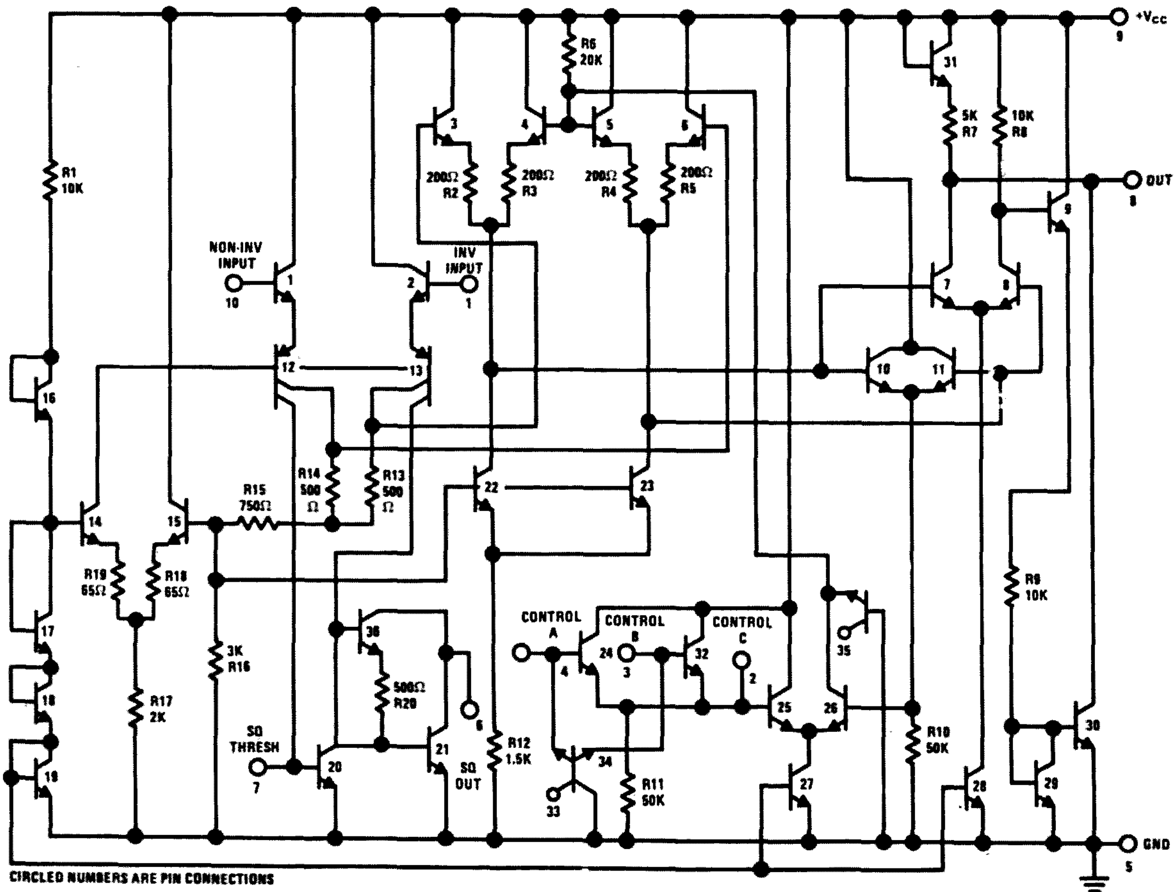

Fig. 4. Complete LM270 Schematic.

arrangement to override the remote control, and shut off the amplifier under present conditions. The resistors and capacitors shown biasing the single-ended input are used to illustrate one way of operating the inputs at a fixed dc voltage; subsequent examples will show simpler schemes.

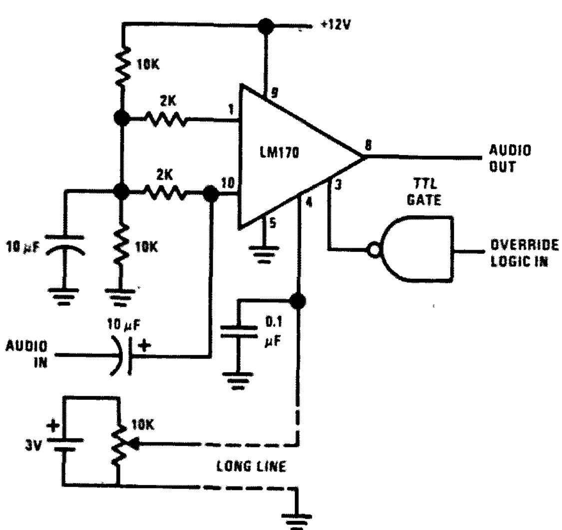

Fig. 5. Remote or digital control amplifier.

Speech compressors

Fig. 6 and **7** are basically audio AGC systems, which respond to peak speech levels above a set threshold by quickly reducing gain to a level which keeps succeeding similar peaks below the threshold. This differs from the usual "speech clipper", as it causes no distortion, but simply keeps the output level at an approximately constant level. In a modulator (any type), such AGC keeps modulation always near, but never in excess of, 100 percent. In **Fig. 6**, a PNP transistor (almost any type will do) adds enough gain to the control loop to operate over a large range of input levels. In **Fig. 7**, the additional gain of the receiver or modulator is used for this purpose. Varying load impedances can cause the gain of these stages to vary; taking the control signal from the system's audio output automatically compensates for load variations, in much the same way as an ALC system operates. The scope photo, **Fig. 8**, shows how the output (vertical axis) remains nearly constant while the input (horizontal axis) varies over a wide range. Note that

both AGC circuits use the internal emitter-follower detectors, and that both inputs are biased from the positive supply through equal resistors, although other biasing works equally well.

Squelch preamplifier with hysteresis

Audio squelch is useful in both receiving and transmitting systems, to cut out background noises. The sensitive circuit of **Fig.** 9 includes a number of refinements, which make it smooth-acting, and easy on QRM weary ears. The threshold pot at pin 7 can be a front-panel control, to cut in at any desired level. Attack time is on the order of a millisecond for nearly any capacitor value at pin 6, but release time is determined by the external RC time constant. The fixed 100 k resistor may be replaced by a 100 k pot, in series with a 10 k resistor, to give operator-adjusted release time.

Part of the voltage at pin 6 is fed back to the threshold pot; since there is an "on" and an "off" voltage at pin 6, this creates a controlled amount of threshold hysteresis, which greatly enhances the circuit's immunity to rapid fading or erratic speech patterns. A typical threshold control setting

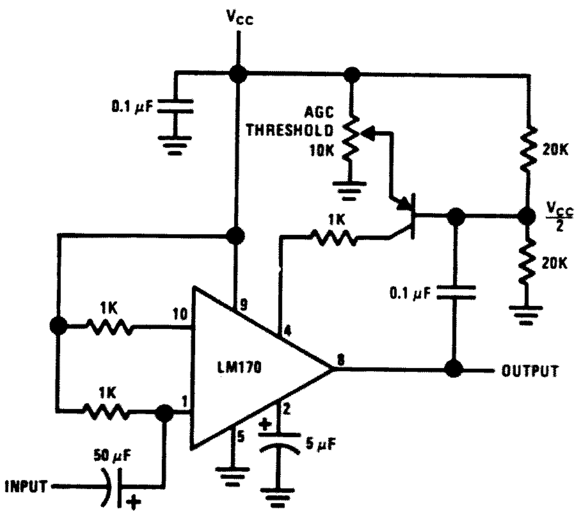

Fig. 6. Speech compressor.

might be one at which amplification cuts in above 20 mV p-p inputs. With the feedback values shown, the input level must drop below 12 mV p-p for a time equal to the RC time constant, before gain is cut off. Shorting across the 200 ohm resistor defeats the hysteresis.

Unlike most squelch systems, which are just switches, the LM270 provides a grad-

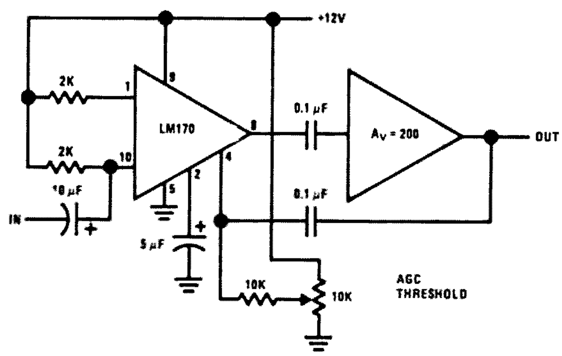

Fig. 7. Speech compressor using subsequent gain for better control.

ual fadeout of background noise, when releasing. This is because the RC combination charges slowly along an exponential curve, and passes through the variable gain region on its way to complete cutoff. **Fig. 10** shows the squelch action with a 25 µF capacitor and 100 k charging resistor. In the upper trace, a constant 1 kHz signal just below the squelch threshold keeps the output, in the lower trace, off. Abruptly increasing the input above the threshold immediately turns the amplifier on. Reducing the input does not turn off the output, but merely reduces it proportionally, during the release period. Finally, after about one second, the output tapers off to zero again.

In this example, another input biasing scheme is illustrated; the LM270 can be driven directly from a high impedance dynamic microphone, such as the Shure 401A, with dc bias for both inputs derived from the positive supply, and no other external components required. In receiver squelch, one of the previously illustrated input arrangements might be used. The high frequency

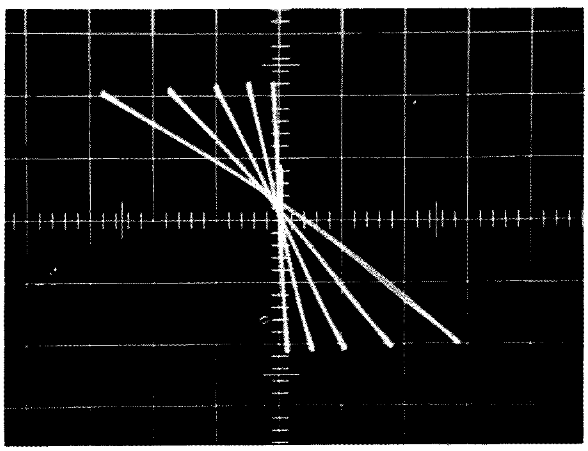

Fig. 8. AGC transfer characteristics, input vs. output, for varying input.

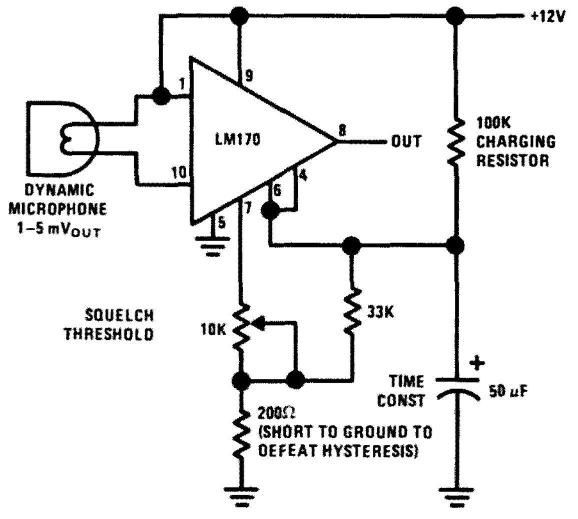

Fig. 9. Squelched preamplifier with hysteresis.

response of the squelch may be rolled off with a .05μF capacitor from pin 7 to ground, to reduce squelch triggering from high frequency noise above the speech spectrum.

A simple VOX mike preamp

Using a small power transistor driving a relay, the LM270 makes a combination VOX and microphone preamp small enough to build into a mobile-type communications mike. With the relay contacts wired across the push-to-talk switch, such a microphone can add VOX to existing transmitters with minimum disturbance of wiring. The basic circuit of **Fig. 11** can be improved, as in **Fig. 12**, by driving one amplifier input from the microphone, and the other from an attenuated part of the receiver's loudspeaker output. (Correct phase must be determined experimentally, by reversing either loudspeaker or microphone leads for best performance.) This takes advantage of the differential inputs provided on the LM270, to cancel ambient speaker signals reaching the mike (anti-trip VOX). A diode shunts the relay coil to protect the PNP power transistor. Any relay drawing less than 100 mA from a +12 volt supply may be used, small model-airplane types being suited for inclusion inside the mike case. In **Figs. 11 and 12,** amplifier gain is not cut off by the squelch detector; however, the VOX circuit may combine with any of the preceding applications to give, for example, a preamp containing both VOX and speech compression.

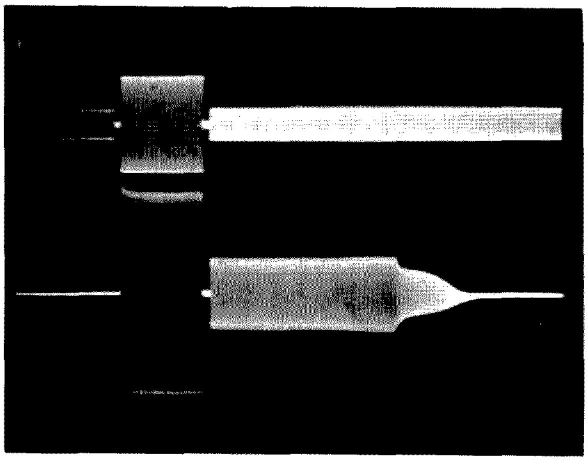

Fig. 10. Fast attack, slow release squelch action.

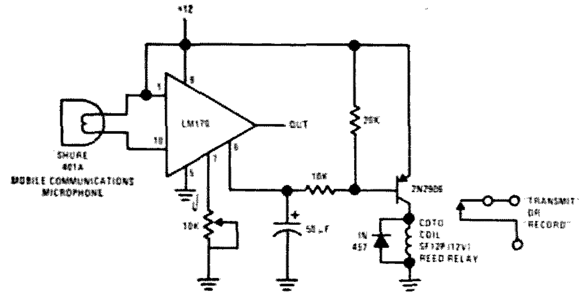

Fig. 11. VOX/mike preamp.

Twin-tee constant amplitude audio oscillator with remote level control

Oscillation occurs in a twin-tee, op-amp type circuit, when total feedback gain equals unity (including filter losses). Conventional methods of regulating oscillator amplitude usually rely on nonlinear loading of the gain stage. With the LM270, however, gain may be set by detecting the output, and using this to force the gain to exactly the minimum value required to sustain low distortion oscillation. The "AGC Oscillator" circuit, **Fig. 13**, automatically compensates for changes in oscillator load impedance. The exact amplitude at which this action occurs is set by an external pot, and may

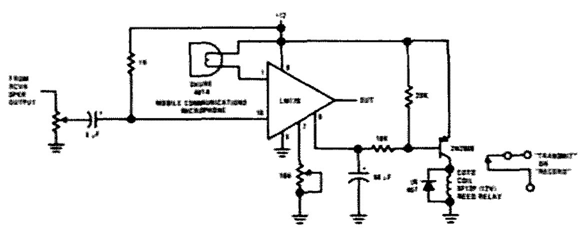

Fig. 12. VOX/mike preamp with anti-trip.

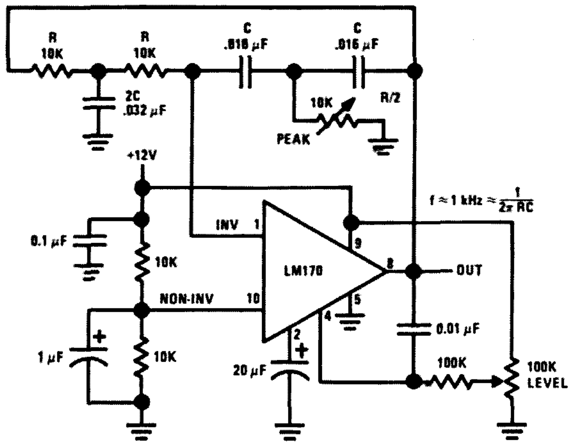

Fig. 13. Twin-Tee constant amplitude audio oscillator.

be set at any value below the maximum undistorted output of the amplifier itself. The "twin-tee" values shown give a 1 kHz output; other frequencies can be calculated from the formula:

$$f = \frac{1}{2\pi RC}$$

A modulated 455 kHz signal generator

An inexpensive, high "Q", 455 kHz ceramic filter can be substituted for the twin-tee feedback network in the preceding example, to make a regulated-output AM *if* alignment generator, **Fig. 14.** If the AGC threshold voltage, which determines the amplitude of stabilized output, is varied at a slow (audio) rate, the output *rf* amplitude will be forced, by the AGC feedback, to track the audio modulation.

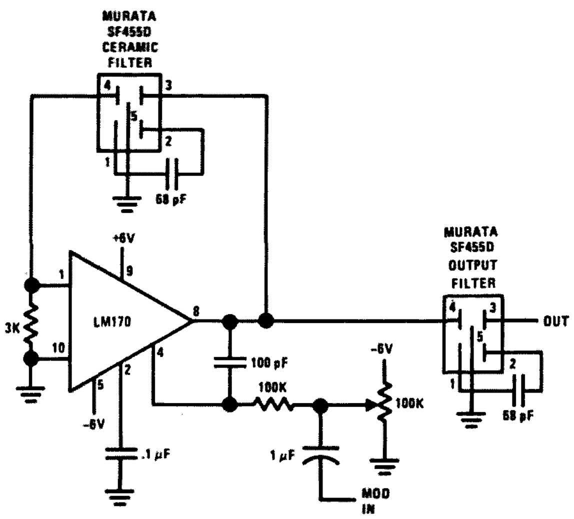

Fig. 14. 455 kHz modulated, regulated output signal generator.

Conclusion

The LM 270 is a very versatile ham IC, which can make your next homebrew rig more advanced than many commercial jobs, with a minimum of the usual headaches. A little thought will reveal many applications, not covered in this article, in speech processing, RTTY, mountaintop repeater control, and others requiring either a variable gain amplifier or a sensitive squelch detector.

Future developments in the communications IC area are going to raise a few more eyebrows; it is expected that nearly all low power level sections of both receivers and transmitters will be built in integrated form in the near future, but these developments must wait for subsequent articles. Meanwhile, whet your appetite with the LM270, the first ham IC. . . . W6DNS

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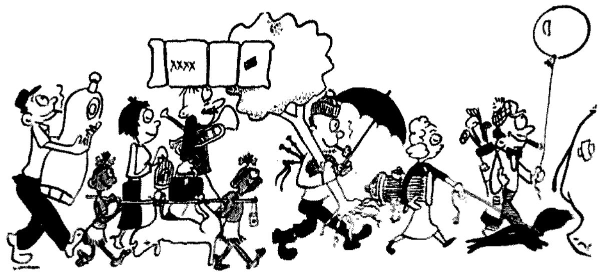
1. *R. Hirschfeld*, "A Unique Monolithic AGC/Squelch Amplifier", Application Note AN-11, National Semiconductor, Santa Clara, Calif. July, 1968
2. *R. Hirschfeld*, "Linear Integrated Circuits in Communication Systems", WESCON 1968 Proceedings, Session 1, Paper 3
3. "Ceramic Filter Data Sheet", Murata Corp. of America, 160 Broadway, N.Y., N.Y. 10038



Moving? Please Let Us Know!

Mouse Tunnels

An Answer to the Rat's Nest

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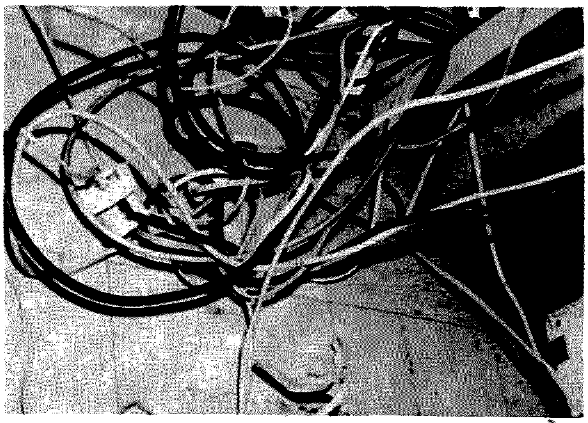
Most of us get a good-sized collection of cable behind the rig, and sooner or later find reason to cuss the tangle it gets into. About the time my roommate (Fred Wirth, WA8DOM) and I couldn't get into certain parts of the room without walking on the wiring, we decided to do something. The objective was to get the wiring out of the way and into a compact form without tying it down permanently and making it hard to rearrange.

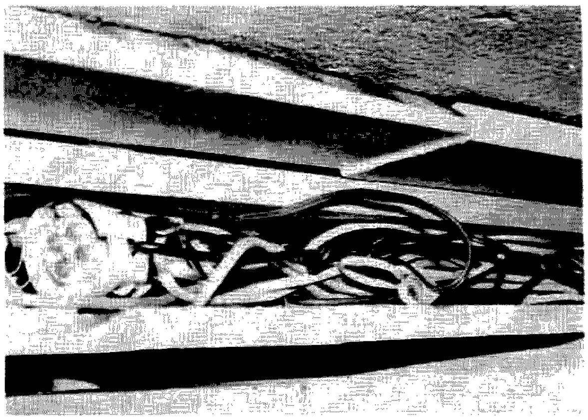
Our answer was the "mouse tunnel," a low-cost adaptation of the sheet-metal raceways used in commercial installations. It's a wooden trough with a lid, 2⅛" x 3⅝" inside, with notches in the front every 6 inches to permit cables to exit where desired.

The photos show most of the construction. After the front board gets its notches, nail a few pieces of scrap wood temporarily to the top edges of the front and back boards to hold them the proper distance apart, so that the joints to the bottom board will hold them that way later on. The two side boards are glued to the bottom, with enough finishing nails to hold them until the glue sets. One every 6 inches is enough. They should be driven below the surface with a nail set, so they won't scratch the floor later.

One small hinge every 4 feet is enough to keep the lid from sliding off, but a section of any lengh should have at least two. No other fastenings are needed, because the weight of the lid will hold it closed with the cables inside.



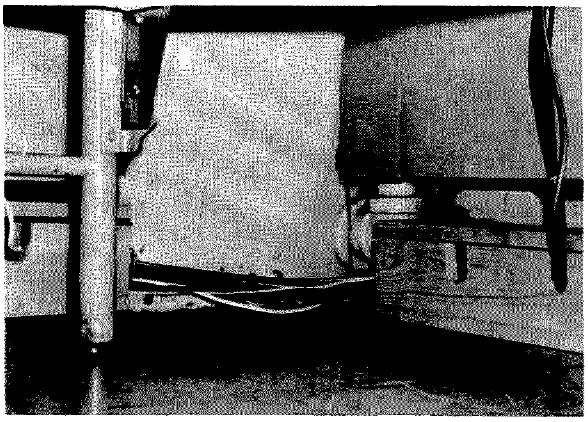
Wiring during rearrangement, about the way it looked before installing the raceways



Cables laid in the tunnel

I built four sections totalling about 20 feet in one evening, and using all new material, spent a little less than $8.

Installation consisted of laying the tunnels on the floor along two sides of the room, putting the cables inside, and closing the lids. Cables come out the nearest notch to each piece of equipment, and excess is snaked back and forth inside the raceway, so there's no pile left on the floor. Changes in the cable runs are relatively easy, because the cables run parallel, and they don't get tangled because they can't be disturbed.



Final appearance—cables in place, lids closed

Wire mesh trough would probably be as good or better, though I haven't tried it. In either case, cost and construction time for a foot-long piece are negligible.

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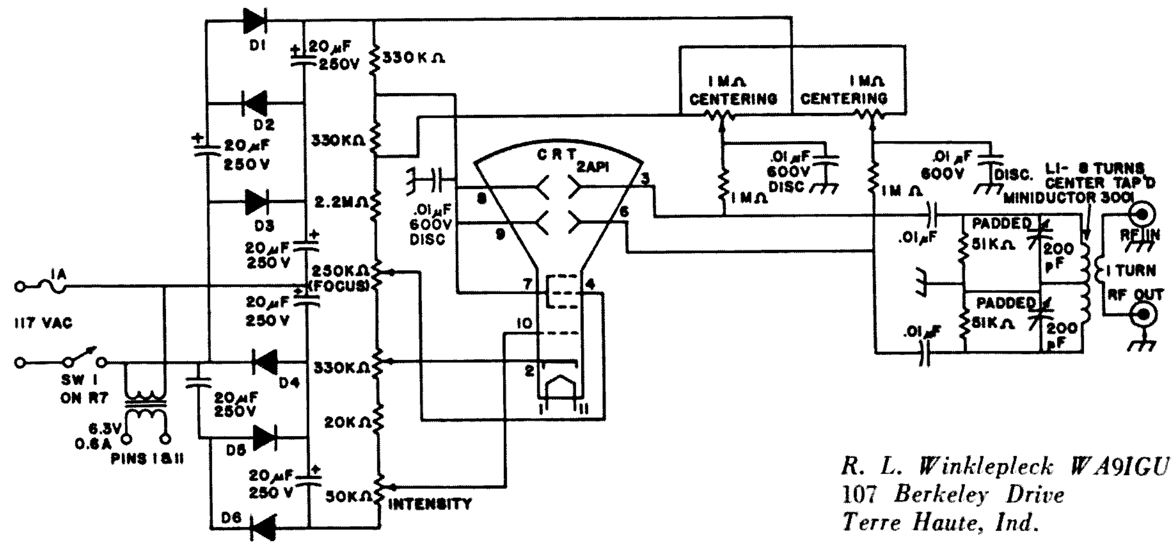

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Circular Modulation Monitor

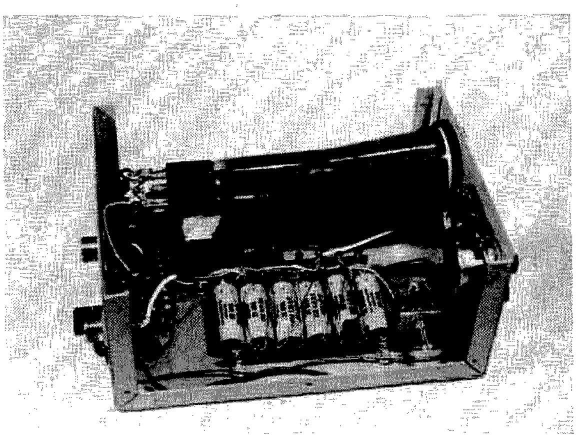
It's as important to keep an eye on your modulation as it is to regularly check your power output. Both characteristics combine to give you a good, intelligible signal.

There are many ways to check your modulation percentage and freedom from distortion. Each method has it's advantages. Nothing, however, is quite as good as CRT observation and here's a unique scope presentation. It'll have you going around in circles.

For a circular modulation indication it's only necessary to shift a sample of your *rf* output 45° each way and feed these two signals, phased 90° apart to the vertical and horizontal plates of a cathode ray tube. This shift is accomplished with a center-tapped inductance with trimmer capacitors across each half. The trimmers tune to the exact phase shift necessary to produce a circle and resistors across the tuned circuits lower the circuit "Q" sufficiently to prevent them from locking in phase. L2, the *rf* pickup link, is adjusted to provide the pattern size desired.

You may use this tuned circuit with any scope you have available or you may build one especially for this purpose. The one illustrated uses a surplus two inch scope tube usually available for a couple of bucks. The circuit is standard except possibly the high voltage supply. High voltage scope transformers are somewhat expensive. The voltage multiplier/rectifier circuit used here is simple and inexpensive. It provides 800-volts and can be duplicated with almost any silicon rectifiers and electrolytic capacitors with a 200-volt or higher rating. Current consumption is only two or three mils so even 5 mfd capacitors will do the job. While it's connected directly across the power line there is no hazard since the chassis is grounded only for *rf*. No horizontal sweep is required.

The chassis is formed from two bent up rectangles of sheet aluminum. Tie strips are used for those components which don't mount directly to the base. The CRT bezel



The row of electrolytics with associated diodes make up the high voltage supply. The mini-ductor on the back panel is L1 and L2 is the single turn of wire with white insulation.

is a plastic wide-mouth bottle cap with the center cut out. It is epoxied in a press-fit hole cut in the front panel. The base of the CRT is supported by the filament transformer. If no socket is available a few pin clips from octal sockets will provide convenient pin connections. Be sure that all 60-cycle and dc voltages are isolated from the chassis. The only chassis grounds, other than in the phase shift circuit, are *rf* bypass capacitors, C7, C8 and C9.

Before *rf* is applied, a single spot will appear on the face of the CRT. This can be centered with R8 and R9 and focused with R4. It's intensity is adjusted with R7. Try one or two turns around LI for L2, connect the transmitter output to one coax fitting and the antenna or a dummy load to the other. If a diagonal line appears before *rf* is applied, reverse the power line plug. Turn on the transmitter and the CRT pattern will become a circle as C12 and C13 are adjusted to produce the 90° phase shift. This circle should be no more than one-half the diameter of the CRT. If it's too large reduce the turns or the coupling of L2. If too small change L2 to increase power transfer.

Modulate your transmitter and an annulus will result bounded by two circles; one larger and one smaller than the circle produced by the unmodulated carrier. As you talk, this annulus will become thin at low modulation levels and quite thick on modulation peaks. The percentage of modulation is equal to the difference of the two radii divided by their sum multiplied by 100. At 100% modulation a completely shaded circle will be produced with a dark dot in the center. A bright dot in the center warns of over 100% modulation.

The CRT pattern also tells several other things about your signal. If the shading of the annulus is not uniform when a steady tone is transmitted some distortion is present. If you adjust to a perfect circle using a purely resistive dummy load an antenna with capacitance or inductance will produce an oval. The amount of distortion accurately indicates the extent of maladjustment. Since the size of the unmodulated circle is directly related to the amount of *rf* in your feed-line this monitor can serve as a very sensitive tune-up indicator.

The value given for LI permits use on the six meter band. By using less inductance you can tune up on two, or move down to the dc bands with more inductance. Increasing LI to ten turns will permit use on the Citizens' Band. The few CB'ers who still are running five watts will need to increase L2 several turns to pick up enough *rf* for a good pattern. The correct inductance for the frequency of interest can be determined from the charts in the Handbook. Possibly a more scientific approach is by cut and try with a grid dip meter.

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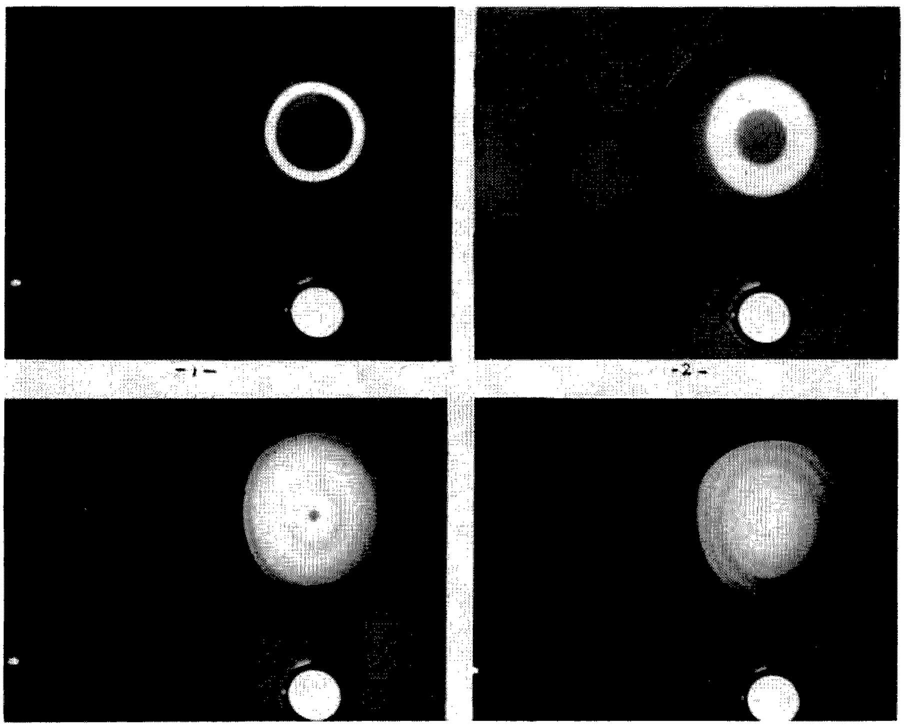
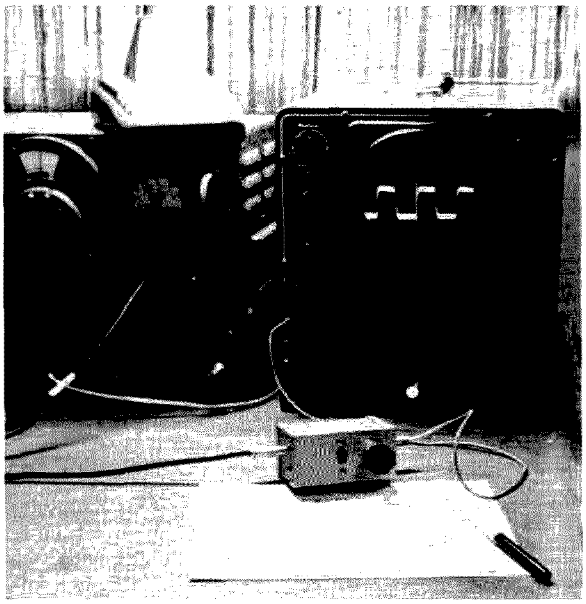


Without a carrier a white spot shows in the center of the CRT. An unmodulated carrier produces a circle.

1. *Very low modulation.*
2. *Approximately* 33% *modulation.*
3. *Nearly* 100% *modulation.*
4. *Bright spot in center warns of over* 100%.

The Mini-Square

Clifford Klinert WB6BIH
520 *Division Street*
National City, CA 92050



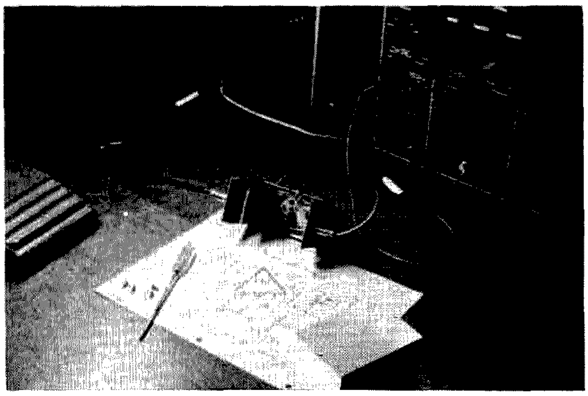
Any technician who has worked with audio equipment knows the value of square waves for checking performance of audio equipment. This article describes a simple and inexpensive integrated circuit amplifier/limiter that can provide a good quality square wave when driven by a sine wave source. The unit should not take more than a weekend to assemble, and will provide the experimenter with an interesting demonstration of the capabilities of this integrated circuit.

The circuit

The CA3011 is a wide band amplifier/limiter that contains ten transistors, seven diodes, and eleven resistors in a TO-5 case. With the connections shown in figure one, taken from RCA, it has a typical voltage gain of 70 db. The input limiting voltage required is about 250 microvolts, but the input voltage for using it as a square wave generator may be as high as several millivolts. It is usable up to 20 MHz, but the gain decreases, and the input voltage required for limiting increases above one MHz. The performance at the lower frequencies may also be reduced. The CA3011 is used typically for FM amplifiers at 10.7 MHz. For information on performance and applications, consult the reference at the end of this article.

Construction

As shown in the photographs, the circuit is assembled on a small piece of perforated board mounted inside a commercially manufactured (LMB) aluminum box. Layout is not at all critical, and almost any method could be used provided that leads are not too long. A small slide switch was used to turn the power off and on from the standard nine volt transistor radio battery. The capacitors can be mylar or ceramic with any voltage rating of ten volts or more. The resistors are half-watt. RCA jacks were used as input and output connectors.



Conclusions

This unit will provide a symmetrical, good quality output wave form, but it must be driven by a good sine wave for best results. Impedance mis-matching can cause distortion in the waveform, and the builder may wish to raise the values of the input and output resistors. For the same reason, varying the output level control may also cause distortion. Increasing the gain control setting on the oscilloscope also affected the shape of the output waveform on the 'scope pattern in the picture.

This has made an interesting project with only a nominal expenditure of time and money, and can introduce the experimenter to other useful and facinating projects in the wonderful world of integrated circuits.

. . . WB6BIH

Reference

Radio Corporation of America. *RCA Linear Integrated Circuits.* Harrison, New Jersey : RCA, 1967.

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Richardson, Texas 75080

Add-On FM Test Set

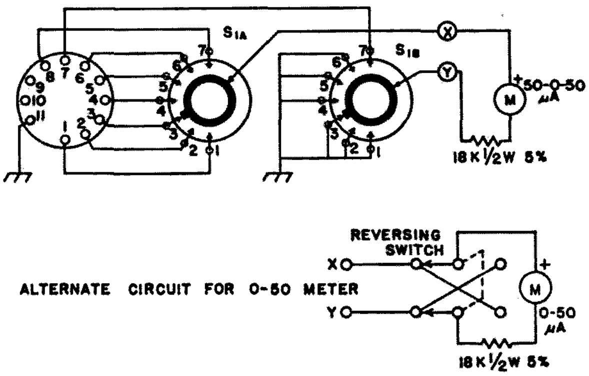

Fig. 1. The basic Schematic for The Casual FM'er.

Most Amateur FM'ers are aware that Motorola base and mobile equipment have central metering jacks for both the transmitter and receiver. These jacks provide a convenient method of measuring each stage during tune-up and alignment procedures. The basic Motorola test set, consisting of the alignment meter, field strength meter, and *if* xtal oscillator, costs approximately $200. The extra deluxe version with the deviation meter and peaking generator costs almost $500. Thus, it is easy to see why most amateurs stick to their VOM's when aligning their Motorola equipment.

The purpose of this article is to outline the construction of a suitable test set for Motorola equipment which can be constructed in varying degrees of sophistication. The basic set consists of a 50 μA meter, and a seven position two pole switch, an 18K 5% ½ Watt resistor, and an 11 pin plug to match the metering socket. This basic unit may be plugged into either the transmitter or receiver to meter the various stages. If a 0-50 μA meter is used a reversing switch will have to be used to allow the discriminator (receiver position 4) to be read in both a positive and negative direction. If a 50-0-50 μA meter is used (as in the K9STH unit) this switch is not needed.

The basic unit may be constructed on a small chassis or mini-box large enough to house the meter and switches. The schematic appears as **Fig. 1.** This unit is quite satisfactory for the casual FM'er who requires limited versatility. In fact, the basic unit is similar to the Motorola P-8449-B metering chassis used in many up-right base stations.

For the more serious FM'er or for clubs which desire a more versatile piece of equipment the basic test set may be expanded in varying degrees. The first expansion consists of adding a microphone and receiver audio output circuits. The microphone circuit allows a conventional Motorola microphone to be used to key and modulate the transmitter without the need for going to the control head. The use of a speaker in the test set will allow incoming signals to be easily heard. The additional circuitry appears as **Fig. 2.**

The third expansion is the addition of field strength meter facilities. The circuit is quite conventional. A short whip may be used for the input circuit. The additional circuitry appears as **Fig. 3.**

The fourth expansion makes the meter movement into a 0-15 VDC voltmeter for measuring automobile battery voltages. This is quite useful for many VOM's do not have a 0-15 volt range. Most meters have a 0-10V and 0-50 V range, which do not allow accurate measurement of 12 volt automobile systems. The calibration of the

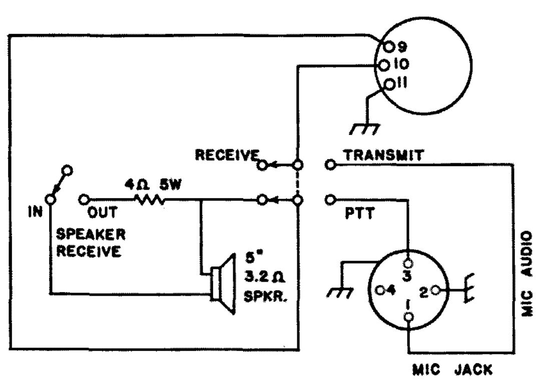

Fig. 2. Addition # 1 Makes Fig. 1 more versatile.

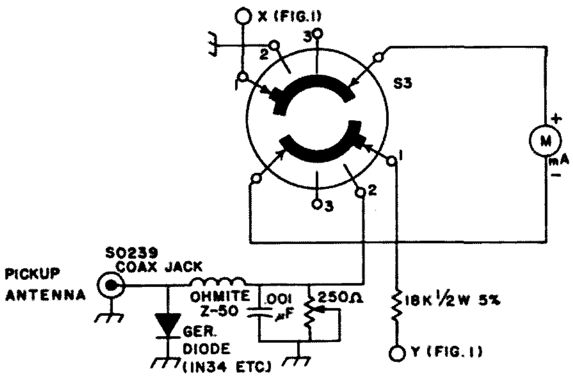

Fig. 3. Adding a Field Strength Meter.

meter can be done either mentally or by the addition of another scale. The easiest method is mental calibration, for each 10 increments on the meter scale represent 3 volts. The additional circuitry appears as **Fig. 4.**

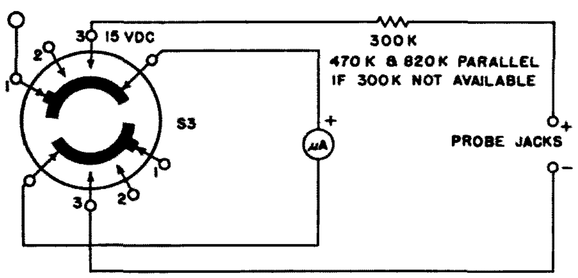

Fig. 4. The Meter becomes a Voltmeter.

The fifth expansion is the addition of a crystal controlled 455 kHz oscillator. This is needed when zeroing the discriminator during receiver alignment procedures. Two other crystal positions may be used for the frequencies of 450 kHz and 460 kHz (for narrow band) or 440 kHz and 470 kHz (for wide band). This allows the low *if* filter to be checked (if the second limiter reading is not almost identical on both crystal positions, the filter is probably defective). Also, the crystal positions may be used to calibrate an oscilloscope for measuring deviation. Since my semi-conductor supply and knowledge are relatively small, I referred to the March 1967 issue of *73*. This is the issue that contains the article entitled "73 Useful Transistor Circuits". The 100 kHz calibrator circuit, figure 62, will oscillate at 455 kHz. The schematic is reproduced as **Fig. 5.**

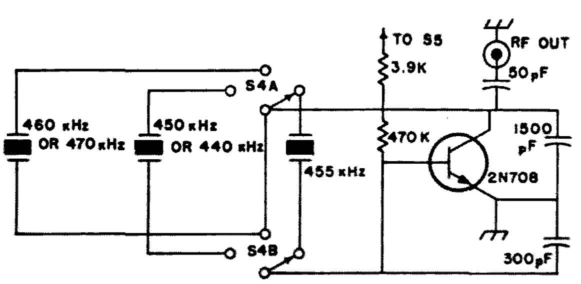

Fig. 5. Adding 455 kHz Oscillator

The sixth expansion is an audio oscillator. When this oscillator is adjusted for an output of 1 volt RMS the deviation of the transmitter may be easily set. Also, an audio oscillator is quite useful in trouble shooting both receiver and transmitter circuits. Again reference is made to the article mentioned above. Figure 61, page 26A, is a 1 kHz oscillator. The value of inductor listed may be hard to find, but an audio interstage transformer (1:3 ratio) worked in a bread-board circuit when the primary was used for the inductor. The schematic is reproduced as **Fig. 6.**

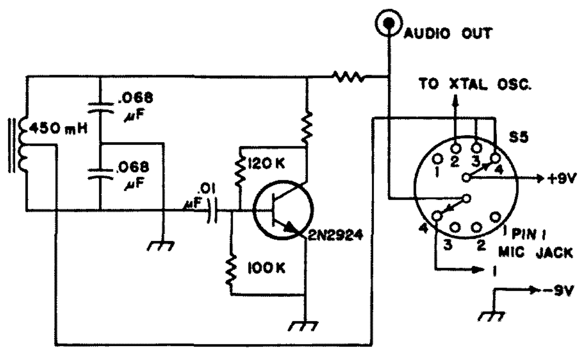

Fig. 6. Audio Oscillator.

The actual constructural details are left to the individual amateur. A medium sized chassis will hold the complete circuit while the smaller versions may be scaled down as needed. The simplest version could be built in a small mini-box with the 50 µA movement of a VOM used as the indicator.

If you are not an active FM'er or have no interest in VHF then this article will have been of no use to you. If you are interested in VHF and/or FM, then I hope that you will find the Add-on Test set a useful addition to your test equipment inventory.

. . .K9STH

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The Elusive H Parameter

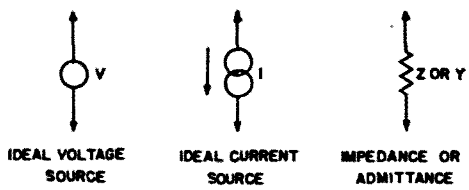


Fig. 1. Basic ideal elements.

Ever since the transistor became readily available at low prices, it has been very popular with experimenters. With a little reading and a good deal of playing around, these people can become quite proficient at this fascinating and relatively inexpensive hobby. Some, however, are quite puzzled at the seemingly nonsensical names given to transistor parameters such as h_{ie} and h_{fe}. A description of the origin and development of the h parameters is not a complicated task, and makes a very interesting story. The first step in this investigation will be to consider a few basic concepts in electronics theory that will be used to introduce the h parameter model and explain its elements.

The model concept

The model is a purely theoretical circuit or element that is used to represent or describe a more complex device. The model is made up of "pure" elements that are interpreted as containing only the properties that they describe. For example, the symbol for an inductor would indicate only inductance, while any real coil would also have a finite resistance associated with it.

Three basic elements that will be dealt with in this discussion are indicated in **Fig. 1.** In part (a), the symbol for a voltage souce is shown. The ideal voltage source is assumed to have zero internal resistance so that no matter what is connected in parallel with it, the voltage will always be the same. The magnitude of the voltage is usually given with the symbol, and is represented by the "V" beside the ideal voltage source. The voltage source also can be a variable source, and the magnitude of the voltage will be given by a mathematical expression, usually the product of two numbers. The ideal current source is shown in part (b) of **Fig. 1.** This element has an infinite internal resistance, and anything that is connected in series with it will have the same current flow, the magnitude of the source. The magnitude of the current is given by "I", and can also be variable or controlled as with the voltage source.

The reader will probably notice a similarity or contrast between the ideal voltage source and current source. The two are precise opposites, or duals. The concept of duality is a useful tool when an individual gets used to working circuit problems in a certain way. If he does not like the way a circuit is arranged, he can change the circuit to its dual, work the problem, and then get the dual of the answer which will then be the desired result in the original circuit. For example, the dual of voltage is current, the dual of capacitance is inductance, and the dual of series is parallel.

The third basic element that will be needed for this discussion is shown in **Fig. 1** part (c). This is the ideal resistance, or its dual the ideal conductance. At this point it will become necessary to make a change in terms. Since the expression "resistance" is valid only for dc, a new term will be needed. The word we are seeking is impedance. Impedance can be used with either dc or ac, and will always mean the voltage in the circuit divided by the current, regardless of whether it is ac or dc. Admittance is the dual of impedance, and will replace the term conductance. The symbol for impedance is Z, and the symbol that will be used for admittance is Y.

The two-port concept

Fig. 2 shows a two port network with an input and output. A signal applied to the

Fig. 2. Two-Port circuit.

left terminals, or port, will appear at the right terminals, modified in some way depending on the contents of the "black box" in the middle. The object in the middle can be any device that is desired, such as an amplifier. It would be handy if we could find a suitable model made up of ideal elements that could be used to represent the behavior of the thing in the black box. One model that could be drawn is shown in Fig. 3. This model can be used to represent a voltage amplifier, and has a characteristically low impedance associated with it. Also, we can take the dual of the circuit as shown in **Fig. 4.** Note that the dual of a voltage in series with an impedance is a current source in parallel with an admittance. It just so happens that this circuit can represent a current amplifier, and has a characteristically high impedance associated with it.

Now all the building blocks are present to enable us to assemble the final model that will represent a bipolar transistor.

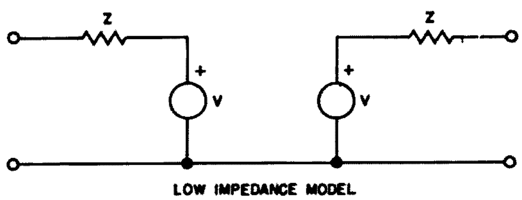


Fig. 3. Low impedance model.

The hybrid model

Since the transistor has a low input and a relatively high output impedance, it is possible to make an appropriate model by combining the models of **Figs. 3** and **4** to give the hybrid model of **Fig. 5.** This model will have a low input impedance and a high output impedance, which is just what we desire. Thus, it is from the word "hybrid" that the h in the h parameters was obtained. The names of the elements in the model represent characteristics of the transistor, and their names were picked completely by convention. The first subscript is used to indicate which particular characteristic in the model is being described, and the second subscript indicates the configuration. The three

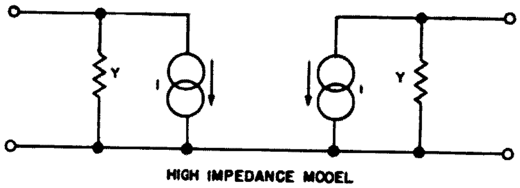


Fig. 4. High impedance model.

Table One
Definition of H Parameters

PARAMETER	COMMON EMITTER	COMMON COLLECTOR	COMMON BASE
INPUT IMPEDANCE	h_{ie}	h_{ic}	h_{ib}
REVERSE VOLTAGE FEEDBACK	h_{re}	h_{rc}	h_{rb}
FORWARD CURRENT GAIN	h_{fe}	h_{fc}	h_{fb}
OUTPUT ADMITTANCE	h_{oe}	h_{oc}	h_{ob}

possible configurations are common base, common emitter, and common collector. These terms are listed in **Table 1** with the underlined word in the left column indicating the word from which the symbol was obtained. Most of the terms are self-explanatory, but the term h_{re} is probably unfamiliar. This refers to the effects of base-width modulation at the emitter junction. This is shown as a voltage source in the input, and tends to oppose the input signal. The voltage source is controlled by the collector-emitter voltage, e_{ce}, and the magnitude of the source is h_{re} multiplied by e_{ce}. The term h_{re} is the one that is often ignored because of its very small magnitude, and is usually insignificant for most applications. The forward current amplification factor, h_{fe}, is the most important parameter, and the value of the current source is h_{fe} multiplied by i_b, the base or input current. This discussion has referred to the common emitter configuration because it is the most popular,

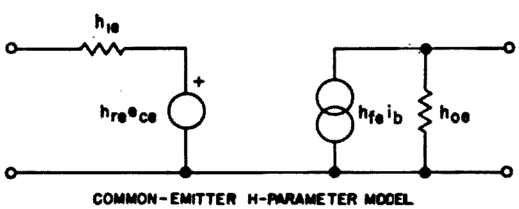


Fig. 5. H parameter model for common emitter.

but a similar explanation could be constructed for the two other configurations as indicated in table one. The model discussed is applicable only to ac signals and does not give any information about dc or steady state voltages or currents.

Conclusion

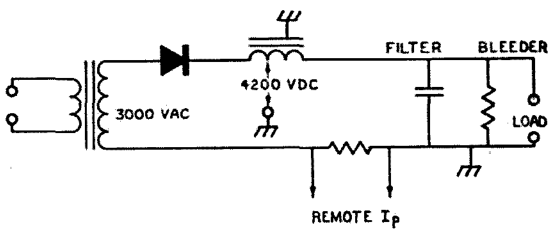
The hybrid model is a very handy tool that was conceived to represent the bipolar transistor and provide a way of naming and describing the characteristics that the designer must know to build any particular piece of electronic hardware where transistors are used. The model is also useful in learning some of the concepts that must be explained in basic transistor theory. Regardless of the way that it may have looked, the h parameters do have a very real meaning, and were not given their names "just for the h of it."

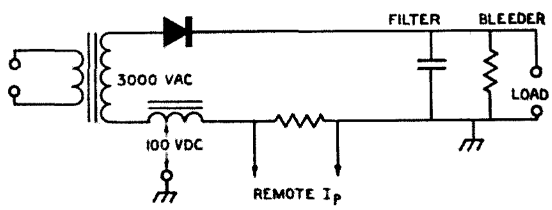
. . . WB6BIH

HV Choke Protection

A common problem with chokes in high voltage supplies is arcing from the winding to the core. This is due to the full supply voltage appearing between these points. A simple remedy is to move the choke from the positive to the negative power supply lead. This reduces the winding to core potential to a small fraction of its original value and for all practical purposes eliminates choke breakdown. The following half wave example demonstrates the required change. Note that nothing about the current metering, load, or protective circuitry is affected.

William P. Turner, WAØABI





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A Zero Temperature Coefficient JFET V.F.O.

The major causes of vfo drift and instability are voltage variations, loading, shock, vibration and temperature. The effects of the first four on oscillator stability can cause chirps, clicks, sudden jumps in frequency and the like. A gradual long or short term oscillator frequency drift on the other hand is primarily a function of temperature.

This article describes a vfo in which the drift due to temperature has been reduced substantially while using inexpensive components and by taking advantage of a peculiar characteristic of the Junction Field Effect Transistor not shared by either tube or transistor: zero dc drift. The FET can be biased to an operating point where its parameters remain constant throughout as large a temperature range as −55° C. to +150° C.

The operating point at which the FET exhibits zero parameter change with temperature is called the zero temperature coefficient operating point and is determined by the FET gate to source bias called V_{gz}. It has been experimentally determined that this required bias is from .6 volt to 1 volt less than FET pinch-off voltage.[1] FET pinch-off voltage Vp is a parameter which appears on FET specification sheets. It is defined in two ways. (1) is is that value of gate to source bias voltage which results in drain current cutoff. (2) it is also that value of dc drain voltage corresponding to a point just to the right of the drain voltage/drain current characteristic curve knee. These two voltages are equal in value. An increase of drain voltage above the V_p value results in a very small increase in drain current.

If the attempt is made to use the published value of V_p in order to determine the zero temperature coefficient operating point V_{gz} we immediately run into a two-fold problem. (1) individual FETs, like transistors, may deviate to a large extent from pub-

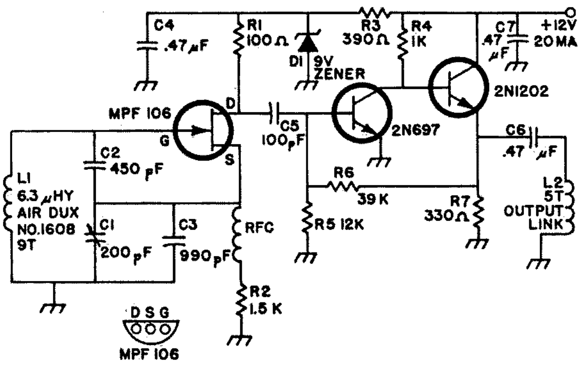


Fig. 1. Schematic diagram.

lished typical specification sheet values. (2) we are faced with the decision to fix a point on a gradually increasing quantity because drain current or gate voltage do not change abruptly in the region of pinch-off. Even manufacturers have difficulty in this regard. A study of several manufacturers specification sheets will reveal drain current cutoff values ranging from 1 milliampere to 1 microampere.

However all is not lost. It simply becomes necessary to measure FET pinch-off. In order to avoid the second difficulty cited above we shall measure pinch-off indirectly. An expression for V_p is:

$$V_p = \frac{2\ Id_{ss}}{G_{max}}$$

$$\text{Where } G_{max} = \frac{E_o}{E_{in}\ R1}$$

I_{dss} is called saturation drain current and is that value of drain current which flows with zero gate to source bias voltage. G_{max} is another FET parameter and is the maximum low frequency FET transconductance. It so happens that this maximum value occurs at zero gate to source bias also. Therefore these two quantities can be measured simultane-

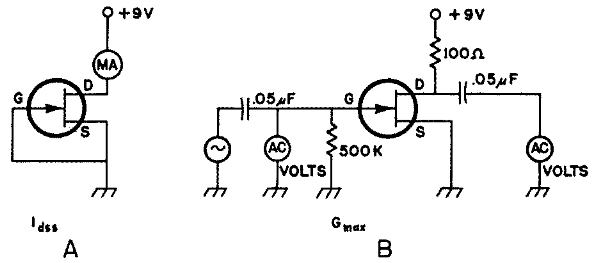


Fig. 2. Simple test set up.

ously. I_{dss} and G_{max} can be measured in the simple test set-up shown in **Fig. 2A** and **2b**. Once I_{dss} and G_{max} have been measured we can calculate V_p by means of the equation for V_p. It then becomes a simple matter to know what the zero temperature coefficient operating point V_{gz} must be. Referring to **Fig. 2B**, E_o is the ac signal output voltage measured across drain load resistor R1 by means of an ac voltmeter. E_{in} is the ac signal voltage input to the FET as measured by the ac voltmeter. E_{in} should be kept in the range of tenths of a volt in order to avoid overdriving the test FET into saturation or cutoff. The signal input voltage should be just sufficient to yield usable readings on the ac voltmeter.

In order to reduce further calculations the graph of **Fig. 3** has been prepared. From this graph the value of drain current can be determined as a percentage of I_{dss} saturation current plotted against pinch-off voltage V_p.[2]

FETs are inherently high impedance devices. In the usual class C oscillator operation the input gate to source junction becomes forward biased during part of the input voltage cycle. The FET input impedance then drops to a very low value and results in heavy damping of the tuned circuit. The presence of the gate leak resistor imposes additional loading of the tuned circuit. In some oscillator designs this has reached a surprisingly low value. The net result is a lowering of tuned circuit Q which in a vfo must be maintained as high as possible. To circumvent this undesirable situation the FET oscillator will be operated class A.

Fig. 1 shows the schematic of a JFET class A oscillator operating at the zero temperature coefficient point in the 3.5 mHz band. The immediate distinguishing features of the oscillator are the absence of the familiar gate resistor/capacitor combination and the presence of the source bias resistor.

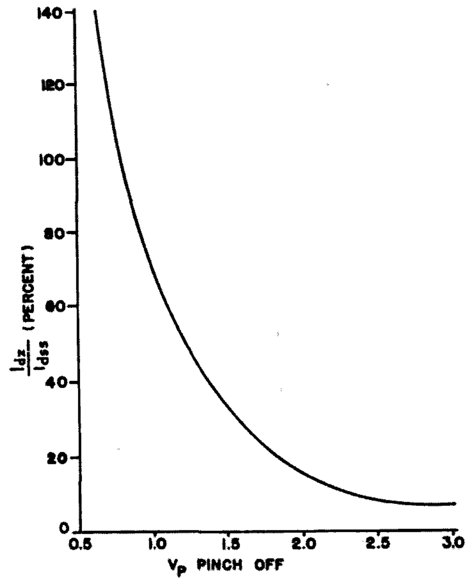


Fig. 3. See Text.

In class A operation the gate-source junction must not be driven into forward bias. Since the gate bias has been fixed due to the considerations described above the only remaining variable is gate signal voltage. Gate signal voltage is determined by the ratio of C2 and C3. The source tapping point is a compromise between sufficient voltage feedback to insure oscillation and a value of voltage which will not overdrive the gate. While the FET is oscillating momentarily ground the gate lead; drain current must not change by more than a barely perceptible amount. As a practical matter, there is nothing particularly critical about the source tapping point and the values of C2 and C3 shown on the schematic are correct for several FET samples.

In this circuit, in which particular attention has been given to achieving maximum drift stability do not expect appreciable power output from the FET. FET power output is in the region of microwatts. A two-transistor buffer amplifier is used following the FET to provide load isolation and yield a usable power output.

No degree of drift stability in the FET can ever compensate for the thermal drift characteristics of the tuned circuit coil/capacitor combination. In ordinary operation a FET is a negative temperature coefficient device. At a gate voltage or bias beyond V_{gz} the FET exhibits positive temperature coefficient characteristics. The intriguing possibility immediately suggests itself that the operating bias can be trimmed to purposely introduce an equal and opposite drift characteristic to that of the tuned circuit. Alternately a thermistor or temperature sensitive resistor can be used in the source lead to introduce a precise temperature drift correction. . . . W6WQC

Appendix

In the vfo constructed by the author a Motorola MPF 106 FET was used. The test results from **Fig. 2A** yielded an I_{dss} of 7 milliamperes. The test result for G_{max} using **Fig. 2B** with .5 vac input yielded .32 vac out across the 100 ohm drain load resistor. G_{max} was therefore 6400 micromhos.

$$G_{max} = \frac{E_o}{E_{in}\ Rl} = \frac{.32}{.5\ (100)}$$

$$= 6400 \text{ micromhos.}$$

V_p was then 2.2 volts.

$$V_p = \frac{2\ Id_{ss}}{G_{max}} = \frac{2\ (.007)}{.0064} = 2.2 \text{ v.}$$

From the graph of *Fig.* 3 $\frac{I_{dq}}{I_{dss}} = 15\%$

therefore $I_{dq} = .15\ (I_{dss})$

$I_{dq} = .15\ (.007) = 1.05$ milliamperes.

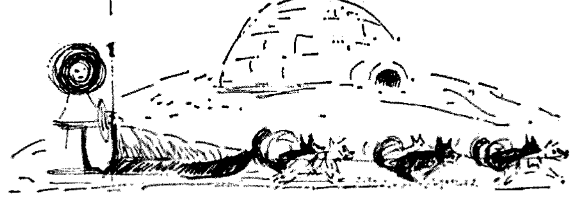
The value of the FET source resistor was chosen to result in a drain current of 1 milliampere. The resistor value was 1.5 k.

References

References

(1) *Specifying FET's*—J. S. Sherwin, Electronics Products, August 1966.

(2) *Behavior of Field-Effect Transistor Characteristics With Temperature*—L. J. Sevin, Texas Instruments Application Note, July 1, 1963.



75 Meter DSB Rig

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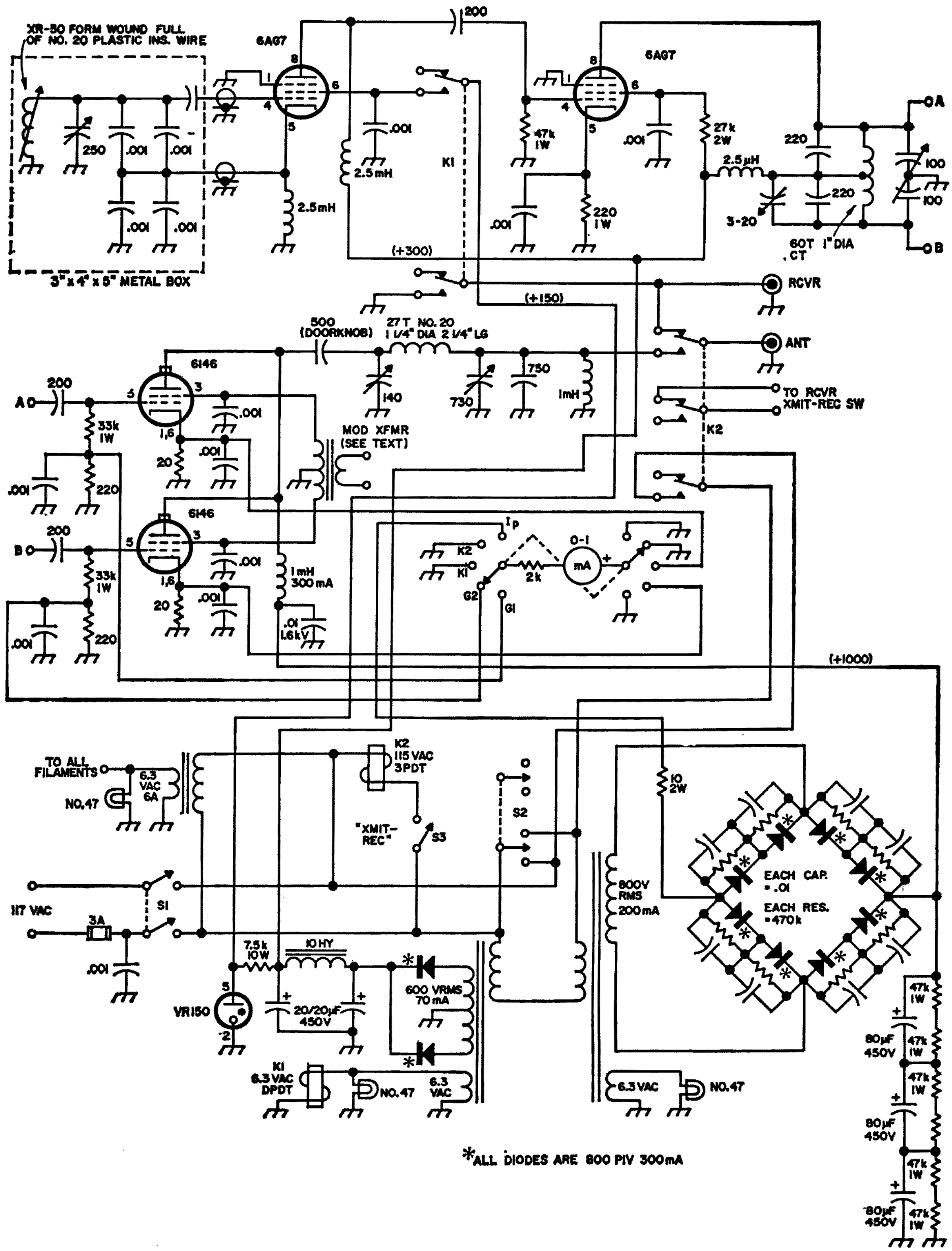
After some ten years of absence from the low frequency ham bands in deference to the sun spot cycle and the lack of space for an antenna for other than six and two meters I heard rumors that ten meters was once more opening up. In a fit of wild spending I purchased a Lafayette HA-350 and started listening in on the low bands. Everybody seemed to be running gallons, half gallons and some poor slobs were only using quarter gallons. To me this was very surprising and just a bit painful to contemplate, as in the old days 100 watts was a thing to reckon with. Everybody seemed to be SSB and anyone who was running an "old fashioned" AM rig always seemed to be somewhat apologetic about his behaviour. To be very honest I don't know a thing about the highly refined theory of how the modern SSB rigs work so I promptly subscribed to "73 Magazine" to get a good ham periodical coming once more into the shack. I cracked the *Radio Handbook* and started to read the ads for commercial rigs. The price structure of an outfit I would like to own caused me to review the finances and after rejecting a new mortgage on the family shack I felt that there had to be a home brew means of getting back on the low ham bands without having the SSB boys become unhappy with "another old fashioned ham" on the band.

The answer I turned to was DSB. Sure I would radiate two sidebands, but that telltale carrier would be so weak that I would maintain my respectability.

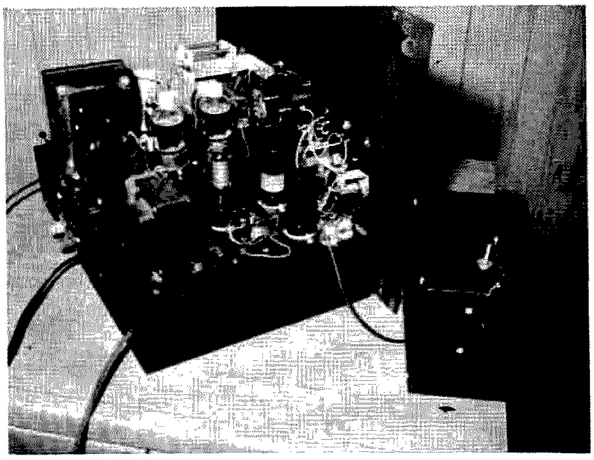
A search of the junk box turned up a couple of 6146 tubes from my old modulator and a husky power transformer from an old TV set. With an assortment of old chassis at my disposal I started to work. The original design called for crystal control but when I went to my friendly ham store and asked for 80 meter phone crystals he looked at me like I was from Mars. He patiently explained that he hadn't had a call for 80 meter phone crystals in seven years. Back to the drawing board. I had heard about the Clapp circuit and all its variations but the good old High C circuit with a 6AG7 was as up to date as I was prepared to be. The VFO was built in a separate 3 by 4 by 5 inch box with heavy components rigidly braced. The main fault of the old High C circuit seemed to be capacitor heating due to the somewhat high circulating tank current. I attempted to avoid this by using four good quality mica's in series parallel in the feedback divider of the oscillator. This plus the lack of heat due to the VFO being in its own box away from all tube heat turned out a VFO that just sits where you set it from a cold start. With a stable VFO under my belt I next turned to an isolating stage between the VFO and the high level balanced modulator. This used another 6AG7 with an untuned or aperiodic grid circuit and a tuned plate circuit. This tuned circuit is a center tapped coil wound on a five inch piece of old broom handle. The coil is shunted by two 220 pF silver micas in series. The variable element is a split stator capacitor (donated by a fellow ham) of 100 pF in each section. The tuning range covers the entire 80 meter band with 10 kHz to spare on each end so there is no chance of accidentally doubling in this stage.

The balanced modulator which feeds the antenna was next. Since the 6146 grids are being fed in push pull the plates have to be tied together to get the carrier eliminated.



This makes the use of a Pi output tank very handy. The audio is fed to the final screens in pushpull. Note that there is no B plus applied to the screens.

Either I didn't have the right books available or everybody but me knows all about feeding audio to DSB screens, but I personally went through a small crisis getting the modulation to perk. Here is what I found out as regards this particular rig. I found that about 130 volts RMS was needed from each screen to ground for full peak modula-



tion. The modulator I used was a junk box three watt amplifier with a 6V6 in the output and an output impedance of 8 ohms. After much trial and error I found that feeding the 8 ohm output of this audio amplifier into the six volt winding of a small power transformer whose secondary was 250-0-250 was just the thing to do. Under modulating conditions the amplifier and the transformers are running pretty much unloaded and this can lead to transient difficulties on peaks which earned me a few reports of lousy audio before I found out how to solve the problem. One side of the 8 ohm primary was grounded and about six dB of feedback was introduced into the modulator from the hot side. This feedback from an essentially unloaded winding acts like a peak limiter, in effect up to a point the quality improves with increased output. With this modification to the modulator the "poor audio" reports vanished. A feedback loop within the amplifier did not do the job, it was only when the output transformer was included in the loop that the problem vanished.

Power supplies

The VFO and the buffer are fed from their own 300 volt supply. The particular transformer used measured 300-0-300 and is a conventional full wave condenser input supply using 800 V PIV rectifiers of the bargain type. Notice that the filament winding on this transformer is used only to light a pilot lamp and to operate K-1.

The High Voltage supply for the 6146 high level balanaced modulator consists of an old TV transformer which gives 800 volts across the secondary. This feeds a full wave semiconductor bridge and is filtered by three 80 mfd 450 volt electrolytics in series. Each diode in the bridge is parallelled with a 470 k 1 watt resistor and a 0.01 disc ceramic for voltage division and spike protection. The entire bridge assembly is mounted on a 4 by 4 by ¼ inch plexiglas sheet. Each electrolytic is parallelled with two 47 K 1 watt resistors in series for voltage division and bleeding purposes. This supply delivers about 1100 volts unloaded and about 1000 volts full load. Respect its ability to put you out of this world if you get careless. Notice that the filament winding of this transformer does nothing but light a pilot lamp indicating that the transformer is hot.

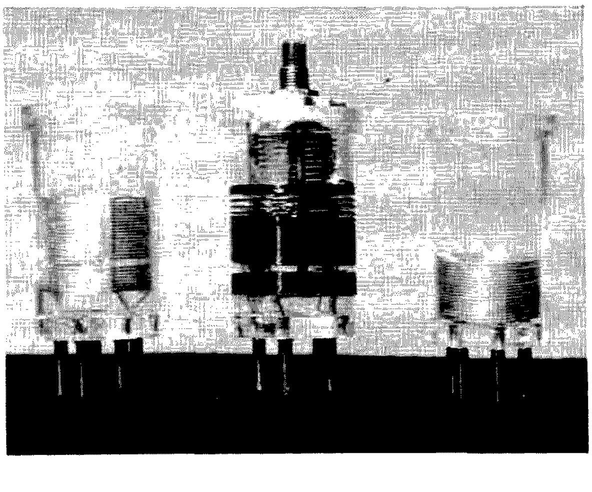
As a tribute to modern technology, the low voltage supply boasts a VR-150 to supply regulated voltage to the VFO screen.

All filaments are lit from a separate six volt six amp filament transformer, which same also sports a pilot light showing that the filaments have been energized.

Relay operation

K-1 performs two functions. The first is to cut off screen voltage to the VFO in the receive mode. If this were not done the VFO would continue to operate until the low voltage supply filters had drained down below about 15 volts. The second function is to throw a shunt across the receiver antenna so that on either the "spot" function mode or transmit the receiver is not overpowered with rf. This Relay is a small DPDT 6 volt ac unit.

K-2 Performs three functions. Frst, one pair of contacts shunts the send/receive switch of the receiver. Secondly, it transfers the antenna from the transmitter to the receiver. The third function is to complete the ac circuit to the high voltage supply primary, and the low voltage supply primary. The switch that operates this relay is the one designated as transmit/receive. (SW-3).



Spot function

In the spot position of Sw-2 K-2 is bypassed and the low voltage primary is energized. K-1 closes, turning on the VFO and shunting the receiver antenna input. When spotting has been accomplished Sw-2 is returned to the normal position and the low voltage supply is once more under control of the K-2 contacts.

Metering

The final stage is the only stage metered. A nine position two pole rotary switch is used with every other position being blank. This is to get enough physical separation between positions for easy marking of the functions. Each grid current and each cathode current is metered for the final tubes accounting for the first four positions of the switch. The fifth position is used to measure total plate and cathode currents along with the small current through the light bleeder on the HV supply.

Electrically the meter is a 0-1 mil movement with enough series resistance to make it a two volt meter full scale.

The grid currents are read across 200 ohm resistors making the meter appproximately 0-10 mA. Each cathode current is read across a 20 ohm resistor making the scale approximately 0-100 mA and the total current is read across a 10 ohm resistor connected between the negative terminal of the bridge and ground. This scale is roughly 0-200 mA. Normal grid current is between three and four mA, normal cathode currents is 12-15 mA with no modulation. Total plate current on voice peaks will hit 60-80 mA on the meter. With steady sine wave input the meter will hit 90-100 plate mils. With this much input the transmitter will fully light a 75 watt lamp used as a dummy load. Actually it's a pretty bright 75 watts but this is subjective and not very scientific so use your imagination.

The only mildly critical thing about the metering set-up is to try to get the two grid current metering resistors as close as possible in value. This will help in balancing the modulator as we shall see later on.

Tune Up from a cold cold start

Plug in the ac cord, cross your fingers and turn on the filament switch (Sw-1) Throw Sw-2 to spot which will turn on both the VFO and the buffer. Tune in the VFO signal on the receiver and set the slug in the coil so that the upper and lower limits of frequency are those that you desire. The prototype hit the upper band limit with the slug almost all the way out of the coil. The phone band covered 80 divisions of the 100 division dial.

Turn the meter to check for final grid current. If you are unusually lucky the currents will be equal but the odds are quite against it. The small 3-20 pF trimmer across the grid tank should be adjusted to make the grid currents equal. Depending on your own physical layout as it affects the capacity balance of the grid tank you have to experiment with which side of the coil the trimmer has to go to be most effective. You only have two choices so it's no big deal to get the right position. Once you have the grid currents balanced the cathode currents may be checked for curiosity but their balance is generally more indicative of the shape the tubes are in than anything else and the readings are not critical as long as they are within 10-20% of each other. Restore Sw-2 to its "normal" position which is opposite to the "spot" position. Connect a 75 watt lamp as a dummy load and plug the modulator into the rig.

Throw Sw-3 to Xmit and recheck the grid current. Using the grid tuning as an excitation control set the grid currents for about 4 mA.

Put some sort of a sine wave signal into the modulator (steal some filament ac thru a resistor if you don't possess an audio generator) and crank up the gain a bit. Put the meter on the plate current position and goose up the audio until it shows about 30 mA. Tune the Pi input condenser for plate dip and the output condenser for maximum output as shown by the bulb load. Then crank up the modulator until the plate current rises to about 80-100 mils. Retune the final tank condensers and if all is well your 75 watt bulb should be glowing with a nearly blinding irridescence. Disconnect the rig and install the mike into the modulator. Talk into the mike and observe the action of the plate meter. A full whistle will make the meter and the bulb agree that power is being produced. It wil also show you that only a professional liar could look at the plate meter under modulation and guess what the input power is. On a rough basis the peak plate current is about 60% over what the meter

sluggishly shows. With a convenient 1000 volts on the plate which makes each input mil an input watt (isn't that convenient) you can questimate to your hearts content what your power input is. What really counts is the other guys receiver combined with your consumate operating skill to make a successful contact.

Making a bulb light up is one thing but getting the soup into the antenna is something else. My own personal antenna for 80 meters is 180 feet of wire that goes from the cellar back to the garage, over the garage roof and back to the old apple tree. Since the Pi net won't match the wild blue yonder impedances of this lash-up (apple trees have very high impedance when used as antenna terminations) I feed the Pi output into an L section, which consists of about thirty turns of #18 wire close wound on a scott towel core followed by a shunt variable of about 200 pF. This lets me feed my long wire in good style. A true space age rf tuning and modulated rf output indicator consists of an NE-2 with a 47 K series resistor shunted across the L section condenser to ground. This little blinking light never fails to impress visitors to the shack much more than the miracle of ham radio communication, the unanimous never varying comment being "ooooh look, that little light blinks when you talk.

Most articles end just about here because the writer has just torn up the tenth rewrite and snarled at his wife and kids for some peace and quiet. The end result is that some things meant for inclusion never get included much to the discomforture of the innocent reader who promptly damns the publisher. Take heart and read on.

Little things that count

If the plate meter is watched carefully as you switch from receive to transmit you will see it bounce to full scale before it settles down to normal readings. This is normal as it is the result of filter charging current.

If you hear a sort of gargling sound in your receiver as you switch from transmit to receive your own particular VR tube may be at odds with the world. Don't throw it out. Just ground the unused contact on K-1 that is on the B plus switching side. This will cure the problem. Personally I like the sound so I took the ground off after I learned it would cure the trouble.

During the spot function you may notice some modulation on your signal if someone happens to talk in the shack and the mike gain is up. This is normal. The rf to the grids of the final *is* being modulated by the audio getting to the screens.

Also regarding the spot function. You may find that having the oscillator and the buffer on during "spot" is just too much rf floating around for your particular receiver. Notice that Sw-2 calls for a DPDT switch but the schematic shows only one set of contacts being used, namely those associated with the low voltage xfmr primary. If you are troubled by excess spot rf simply wire the unused contacts of this switch so that the buffer plate and screen gets no B plus in the spot function mode. If you wire the rig in this manner don't forget to short out the switch connections during the initial first tune up or you will not be able to check the grid drive and set the grid balance as described earlier. After this balance is set remove the shunt from the switch and you are in business.

Make sure that the modulator you use will give a good three watts of clean audio measured into a resistive load. If you do this and troubles arise you can be sure that it is not "Modulator power." It helps greatly to tailor the audio response of the modulator. Ideally it should be well down by 250 cycles and roll off pretty well by 4500-5000 cycles. If somebody says you sound mushy it means you forgot something. What you forgot is that the screen bypasses in the final are across the high impedance winding of the modulator secondary. Do your high frequency roll off correcting with these shunt condensers in mind and you won't get a "mushy" report.

The VFO inductor utilized a national XR-50 slug tuned coil form wound full of #20 plastic insulated hook up wire. This may cause some consternation from the purist to use such wire for a VFO inductor, all I can say is it works just fine.

The Final tank inductor is in reality a part from an ARC-5. It is a winding as described, wound on a beautiful ribbed ceramic form. It cost all of forty cents at Fertik Electronics, 9th & Tioga streets here in Philadelphia.

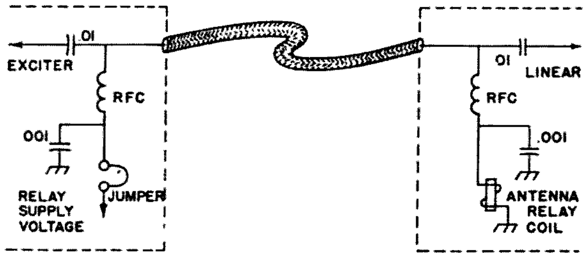
The three pole double throw 115 volt ac relay came from the same place with a $1.50 price tag. Naturally you can substitute other coil voltages depending on your junk box.

The virtue of the control set-up as described is that there is but one switch to throw in going from transmit to receive.

This little rig puts out a clean DSB signal. It has given no TVI trouble although I do make it through the little 5 tube acdc cracker box in the kitchen, a la donald duck. The low frequency bands have changed greatly in the last ten years but some things never change. If you have some guy running a gallon on your frequency, you lose. Howsomever, intelligent listening, picking your spot, plus a good receiver and a fair amount of good old fashioned ham courtesy will let you make many enjoyable contacts with this rig. Happy DSB.

. . . W3KBM

Controlling the Linear Changeover Relay



One of the design considerations faced by the builder of a linear amplifier is how to activate the antenna changeover relay within the linear.

It can be done directly with a switch or in a more elaborate manner with an *rf*-biased tube with a control relay in the plate circuit.

The system shown here, particularly useful in connection with a mobile truck-mounted linear amplifier, impresses the relay control current onto the coax link between the exciter and the final right along with the *rf*.

.01 dc isolating capacitors must be used at either end of the line as shown, if not already present. The *rf* chokes can be almost any variety that will safely handle the relay current, since the *rf* voltage is low on a low impedance line and hence not very demanding on the characteristics of the chokes used.

A removable jumper or a switch must be used at the exicter end to disconnect the relay supply voltage when the exciter is used to drive an antenna directly.

R. B. Kuehn WØHKF

Sam Creason K6DQB,
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A Novice FET Converter

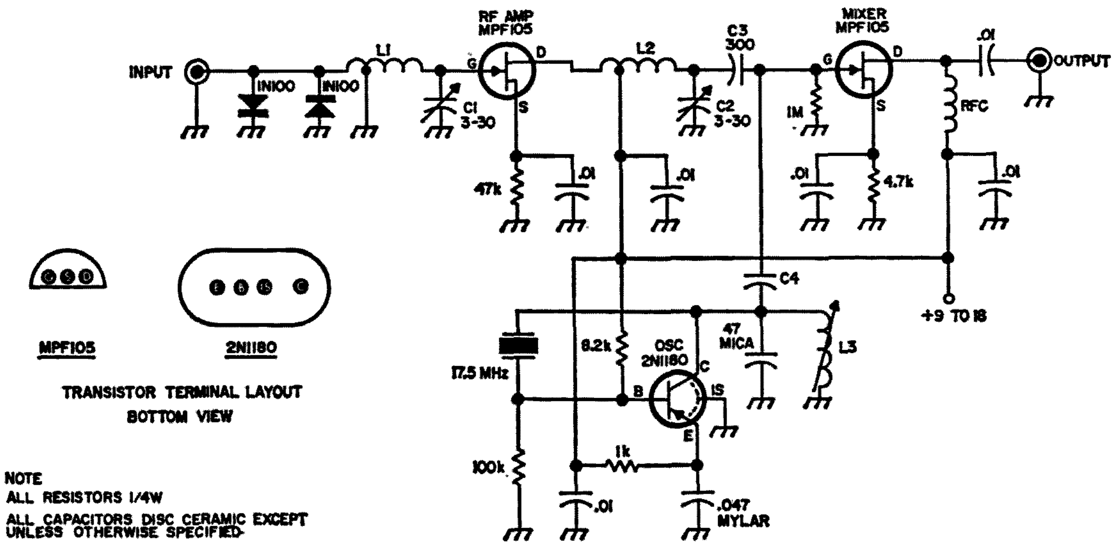


Fig. 1. Schematic diagram of the Novice Converter.

Because the author has obtained good results from home-brew multi-band FET converters[1,2], an effort was made to design a 15 Meter converter suitable for construction and use by the novice. The resultant converter is stable and performs well when used with a reasonably good 80 Meter receiver.

The converter schematic is shown in **Fig. 1.** Motorola MPF105 FET's are used for the rf amplifier and mixer, while a 2N1180 is used as the local oscillator. For the Novice who is looking at his first converter schematic, the following paragraph may be helpful:

The heart of a converter is the mixer stage, which, in the Novice FET converter, consists of those components to the right of C_3 and above C_4 in the schematic. After passing through the *rf* amplifier, a signal from a distant Novice's transmitter, between 21.10 and 21.25 MHz, is applied to the mixer through C_3, while a 17.5 MHz signal, generated in the local oscillator, is applied through C_4. If the Novice signal is at, say, 21.15 MHz, then an inspection of the mixer output will reveal (among others) a signal at 3.65 MHz, which is "identical" to the Novice signal, except for frequency. The mixer has combined the 21.15 MHz Novice signal and the 17.5 MHz local oscillator output to produce a signal corresponding to their difference frequency, 3.65 MHz, which can be received on an 80 Meter receiver. A little arithmetic will show that the entire 15 Meter Novice band can be tuned by tuning the 80 Meter receiver between 3.60 and 3.75 MHz.

The *rf* amplifier is designed to provide only enough gain to override the noise generated in the converter, thereby minimizing susceptibility to cross-modulation. However, the use of stagger tuned input and output circuits to broaden the bandpass of the *rf* amplifier may degrade the converter performance somewhat in this respect. Inductors for the tuned circuits are wound on toroid cores for the sake of compactness and to minimize coupling between coils. Since the magnetic flux of a toroidal coil is almost completely contained within the coil, magnetic coupling between the input and output of the *rf* amplifier is minimized and no shielding is required. As it stands, the *rf* amplifier (and the entire converter) is stable either with or without an antenna connected.

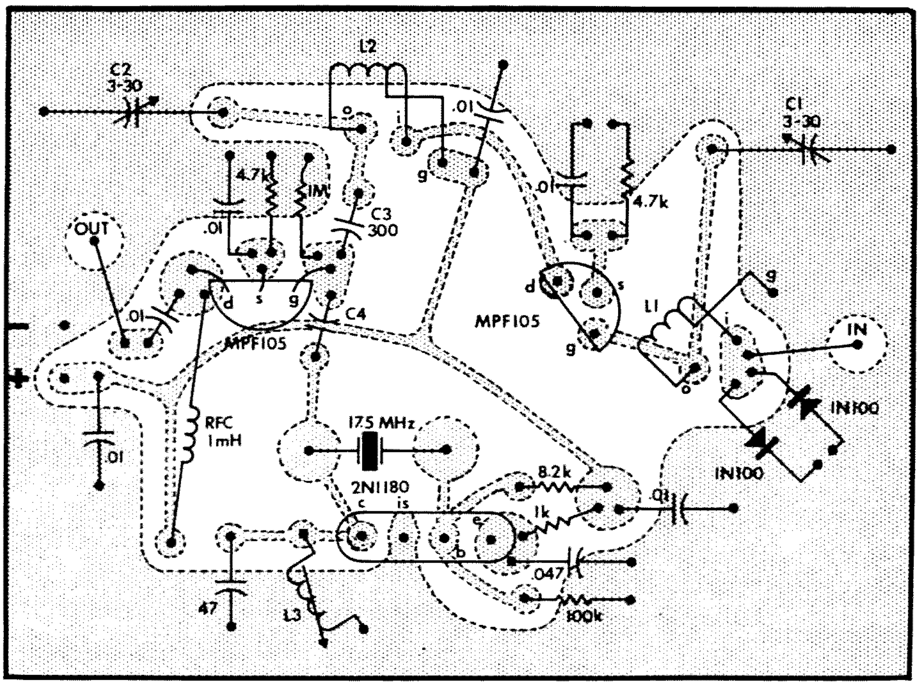


Fig. 2. Component side of the printed circuit board for the Novice converter.

Three models of the converter were made using conventional air-core coils and all were unstable to a degree, even with shielding.

A pair of 1N100 diodes is connected across the converter input to prevent excessive voltages from being applied to the first FET when the station transmitter is on the air.[3] A socket is provided for this FET to facilitate replacement, if necessary.

Coil data

C_4—two 2-inch lengths of insulated hookup wire twisted together.

L_1—23 turns no. 24 enamel wire, tapped at 4 turns, on 1/2-inch O.D., 5/16-inch I.D., 3/16-inch long powdered-iron toroid core. (Ami-Tron Associates T-50-2 Red).

L_2—21 turns no. 24 enamel wire, tapped at 4 turns, on same type form as L_1

L_3—25 turns no. 30 enamel wire, close-wound on 1/4-inch diam. iron slug tuned form (Miller 20A000RBI usable).

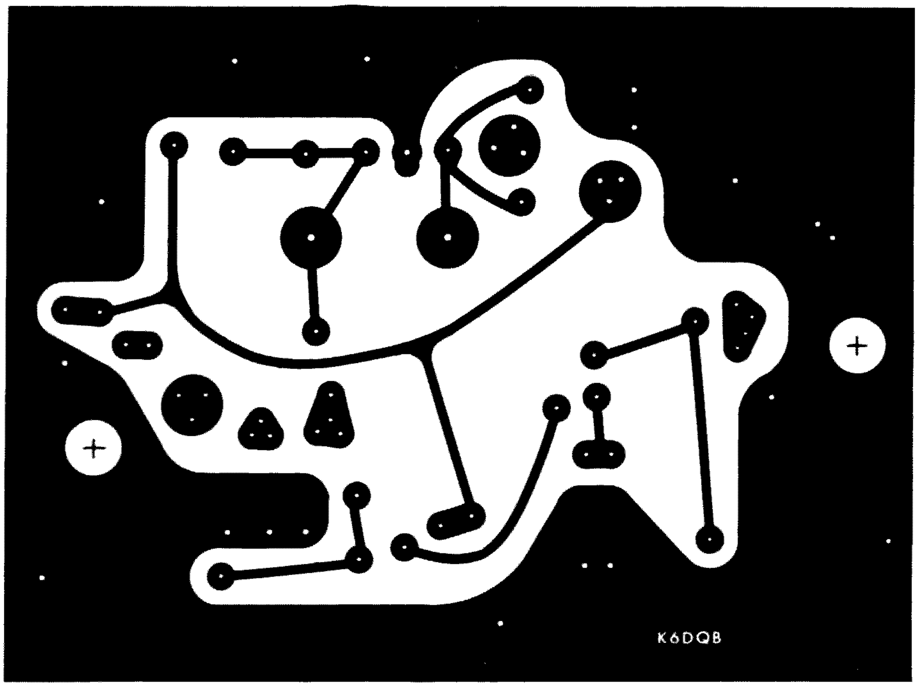


Fig. 3. Copper foil side of the printed circuit board for the Novice converter.

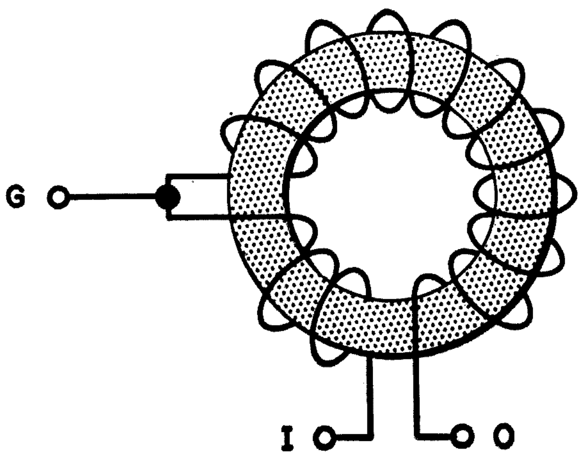


Fig. 4. Detail of the toroid.

The converter is constructed on a 3 x 4 inch printed circuit board as shown in the photograph. The component layout and masking pattern are shown in **Figs. 2 and 3.** The author used an E-Z Etch kit from Ami-Tron Associates[4] which contained a 4 x 6 inch board, etchant powder, and masking material. The board was cut in half and etched with half the etchant supplied. Although the kit provides ample masking material for making narrow lines and small circles, there is no provision for masking the large solid areas at the edges of the board. A heavy coat of fingernail polish makes an acceptable mask for this purpose and can be removed with polish remover or steel wool after etching is complete.

The tuned circuit inductors are wound on toroid cores which were also obtained from Ami-Tron. A convenient method for tapping the coils is shown in **Fig. 4.** Starting with the input (I) lead, add turns until the tapped turn is reached. Form the wire into a U on the outside of the toroid and twist the sides of the U together. Scrape away the enamel at the bottom of the U (but do not break the wire) and solder on the ground (G) lead. Continue winding until the required number of turns is in place. The turns should be spaced around the full circumference of the toroid.

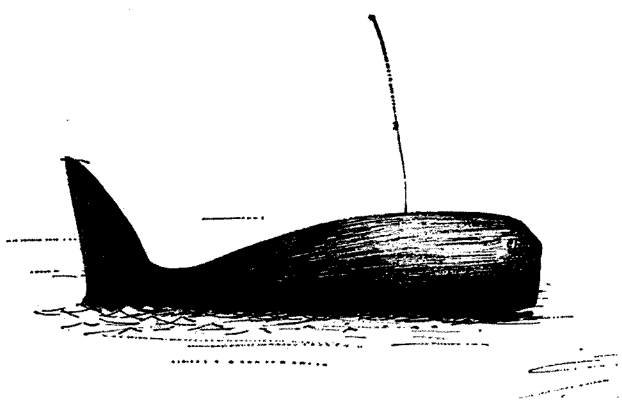
The transistors and diodes should be the last components to be soldered to the board as they are quite susceptible to heat damage. As a transistor or diode lead is soldered to the board, it should be held firmly by a pair of long nose pliers on the component side of the board. The pliers will act as a heat sink and protect the device.

After the converter is completed, check the foil side of the board for accidental shorts, poor connections, and the like. When all is in order, insert the 17.5 MHz crystal and the *rf* amplifier FET in their sockets, connect the converter to an antenna and 80 Meter receiver, and apply power. *Never insert or remove transistors with power applied.* Tighten the screws in C_1 and C_2. If no Novice signals are heard when the receiver is tuned between 3.60 and 3.75 MHz, adjust the slug in L_3 until they are. Tune in a weak 15 Meter Novice signal near 3.65 MHz on the 80 Meter receiver and adjust the slug in L_3 and the screw in C_1 for loudest signal. Then tune in a 15 Meter Novice signal near 3.70 MHz on the 80 Meter receiver and adjust the screw in C_2 for loudest signal. If either signal is loudest when the screw of C_1 or C_2 is fully clockwise (maximum capacity), add a turn or two to the output (O) end of the appropriate coil and readjust the capacitor.

The author has no means by which to quantitatively evaluate cross-modulation susceptibility, but the converter seems to perform well in that respect. It's sensitivity is about the same as that of the 'authors' 10-20 Meter FET converter of similar design. For a $15 investment (if all parts are purchased new), it gives a good account of itself. . . . K6DQB

Bibliography

1. Creason, *A Field Effect Transistor Converter For 10, 15 and 20 Meters,* 73, May, 1967.
2. Creason, *A Field Effect Transistor Converter For 40 and 160 Meters,* 73.
3. Jones, *Using Low Cost FET's on Six,* 73, February, 1967.
4. Ami-Tron Associates, 12033 Otsego St., North Hollywood, Calif., 91607. The 1-board E-Z Etch kit sells for $3.49, the T-50-2 Red toroid core for $0.45.



Transceiver Review

Heathkit SB-101

Heath is producing a sizable line of transceivers, and at the top of the pile we find their SB-101 transceiver tuning all ham bands over 80 thru 10 meters. It goes in a case 14⅞" x 6⅝" by 13⅜" deep, and weighs 17½ pounds. The kit comes for $340, or you can purchase it assembled for $540. An external power supply is required priced at $64.95 for the mobile 12-volt supply or $49.95 for the ac supply.

Tuning ranges and stability are guaranteed by Heath's preassembled Linear Master Oscillator. Receiver sensitivity is better than 0.5 microvolt for 10 db. signal-plus-noise to noise ratio in sideband operation. Sideband selectivity is 2.1 kHz at minus 6 db., 5 kHz at minus 60 db. for a 2:1 shape factor. An optional filter is available for CW work offering 400 Hz bandwidth at minus 6 db. and 2.0 KHz at minus 60 db. When this filter is installed a choice of filters is available from the front panel.

Transmitter final power input is 180 watts PEP continuous voice, or 170 watts CW at a 50% duty cycle. RF power output is 100 watts to a 50 ohm nonreactive load on 80 thru 15 meters, down to 80 watts on 10 meters.

Transmit-receive control is PTT or VOX on sideband, keyed-tone VOX on CW. A CW sidetone is available to speaker or phones when operating CW.

Heathkit HW-100

Heath's Single-Banders have been extremely popular and several conversion articles have appeared describing modifications for greater utility. Seeing the writing on the wall, Heath has recently introduced a 5-band version of their Monobanders, with a few trimmings thrown in from their more expensive SB-101A rig. The economical design methods and use of already-available engineering components have held the price down to $240 for a really versatile piece of gear.

The HW-100 weighs under 18 pounds, uses a Monobander power supply to run 180 watts PEP sideband or 170 watts CW. Operating range is 80 thru 10 meters in five bands, and frequency stability is less than 100 Hz per drift after warmup or for plus/minus 10% line voltage drift. Sensitivity is better than 0.5 microvolts for 10 db signal

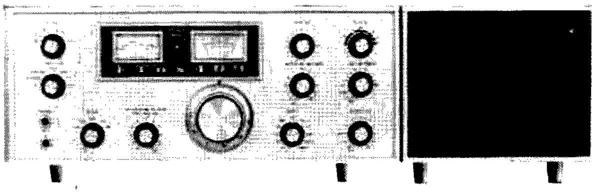
to noise ratio, and filter bandwidth is 2.1 kHz at minus 6 db, 7 kHz at minus 60 db.

Heathkit HW-12A, HW-22A, HW-32A.

Shown above is Heath's HW-12A, one of three 200 watt PEP single-band transceivers that have been very popular over several years. All are designed to use the same stable low-frequency VFO, tuning from 1.5 to 1.8 MHz, and in their latest form all offer a choice of upper or lower sideband. Size is 6¼" x 12¼" by 10" deep, weight 15 pounds for all models.

Separate power supplies are required, and these are available for ac operation, or for dc mobile application.

Receiver sensitivity is 1 microvolt for 15 db signal to noise ratio, audio output 1 watt into 8 ohms. Drift is 200 Hz per hour after warmup, selectivity fixed by a crystal lattice bandpass filter. Carrier and unwanted sideband suppression is 45 db. HW-12A, $99.95; HW-22A, $104.95; HW-32A, $104.95.



YAESU FTdx 400

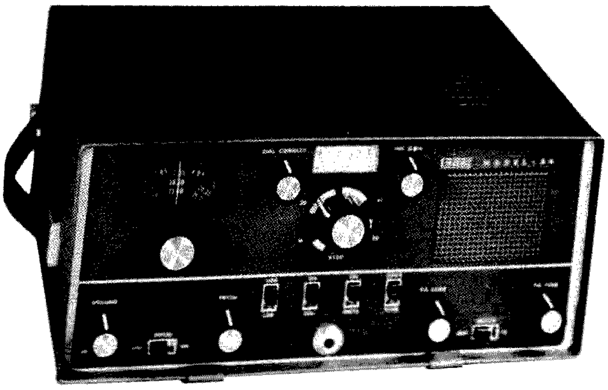
A recent arrival from Japan, the FTdx 400 transceiver was planned and designed for the American amateur utilizing standard locally-available parts. It covers the bands 80 thru 10 meters, with provision for three additional 500 KHz receiver bands. Frequency stability is better than 100 Hz drift per 30 minutes after warmup.

The transmitter is rated at 500 watts PEP sideband, 440 watts CW or 125 watts AM. This transceiver has a built-in power supply, which must be a pretty good one because although the transceiver is not notably larger than others it is considerably heavier: it weighs 50 pounds. Its cabinet size is 15¾" x 6¼" by 13¾" deep.

Receiver sensitivity is 0.5 microvolt for 20 db. signal to noise ratio on 14 MHz sideband. Bandwidth is 2.3 KHz at minus 6 db. and 3.7 KHz at minus 55 db. with IF and RF images better than 50 db. down. Audio output is 1 watt at 5% distortion, and frequency stability is less than 100 Hz drift per 30 minutes after warmup.

Active elements are present in unusual profusion. The Yaesu transceiver uses 18 tubes, which is about average, but it also has 42 additional semiconductors in a hybrid circuit, designed to make the most effective use of both tubes and semiconductors. One unusual feature is calibration points at 25 KHz intervals as well as 100 KHz points, with vernier dial accuracy specified as better than 500 Hz when calibrated at the nearest 25 KHz point.

Any units not shown in this review are not due to lack of editorial interest, but because the manufacturer did not send us information.

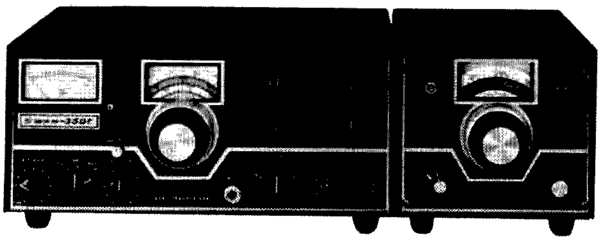


SB-34

The SB-34 is unlike most transceivers in having a built-in power supply. And the supply is a universal type, which will operate from either a 12 volt battery or from 117 VAC. The only revision required is a change of leads. And for mobile operation the SB-34 has a low-drain standby setting which turns off the transmitter tube filaments and some other circuitry to reduce car battery drain to ½ ampere.

Frequency coverage is 3.775 to 4.025, 7.050 to 7.300, 14.100 to 14.350 and 21.200 to 21.450 kHz, with 1 KHz divisions on all bands. Selectable upper or lower sidebands, three IF's with a collins Mechanical Filter on 455KHz.

Case size is 5" x 11¼" by 10" deep, weight 19 pounds. The transmitter PEP input is 135 watts to two 6GB5's, and drift is under 100 Hz per 30 minutes under normal ambient conditions.



SWAN 350C

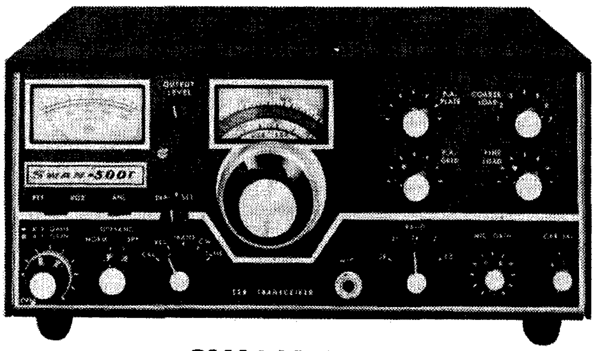
Looking at the model designation you might believe the Swan 350C is rated at 350 watts somehow. Actual ratings are 520 watts PEP sideband input on all bands, 360 watts CW and 125 Watts AM SSB plus carrier.)

Receiver sensitivity is better than 0.5 microvolt for 10 db signal-plus-noise to noise, with audio output rated at up to 4 watts into a 3.2 ohm load. Filter specs are 2.7 kHz at minus 6 db, 4.6 kHz at minus 60 db, and ultimate rejection better than 100 db.

The tuning range is 80 thru 10 meters in five bands. Metering checks PA cathode current to 800 mA on transmit, with the same meter indicating up to 70 db over S9 on receive.

Swan's Operation & Maintenance manual contains some very nice material about sideband theory and operation, and includes some useful information. For instance, if a sideband signal is transreceived at 20 db over S9 and the unwanted sideband is suppressed 50 db (Swan's spec for their 350C) the unwanted sideband will be audible at about S5. The manual is a strong sales point for the transceiver. Price: $420.00.

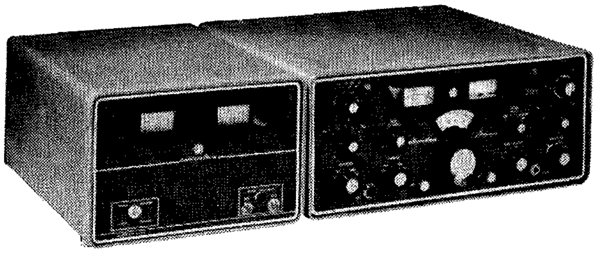
A power supply with speaker is available for 117 vac operation, at $105, or for 230 volt operation at $115. Another supply without speaker is available for $65. For dc mobile operation an ac supply can be used with Swan's Converter Module, at $65, or the ac supply can be left in the house and the Swan operated from a complete 12 vdc supply costing $130. The new 500-C Swan described below uses the same power supplies as the 350C.



SWAN 500C

The new Swan 500C is similar to the 350C, but has been refined by the introduction of a pair of RCA's 6LQ6's, development of the drive mechanism, a new *if* frequency of 5.5 MHz, and an increased number of tuned circuits in the receiver. All this has upped the price from the 350C's $420 (the 350C is still in production) to $520 for the improved model.

General technical specifications remain about the same, but Swan mentions the new 6LQ6 final can usually get up to 570 watts before flat-topping. Also, the new Swan has acquired a number of additional diodes and two new tubes. One of these is a 100 kHz crystal calibrator, optional in the 350C. The new panel suggests other changes not mentioned in the manufacturer's literature.



Hallicrafters SR-400

Hallicrafters' SR-400 contains some interesting ideas in transceiver design. For instance, it has a noise blanker circuit that turns off the receiver *if* when noise pulses exceed a given level. This prevents overloading and blocking, allowing the *if* to return to operational condition in far less time than would be required for an overloaded circuit to recover.

The SR-400 comes in a 16½" x 7¾" x 15" deep case. Power supply is external, and may be Hallicrafters' PS-500 supply containing a loudspeaker. or a dc supply operating off 11 to 16 volts for mobile operation.

Transmitter linear power input is 400 watts PEP on sideband, or 360 watts maximum for CW. Distortion products are down 30 db minimum, carrier and spurious emissions 50 db below rated PEP output. An 800 Hz sidetone oscillator is provided for CW monitoring.

Tuning ranges cover 80 thru 10 meters in eight 500 kHz bands, with the variable-tuning portion of the circuitry always operating in the range of 6.0 to 6.5 MHz. The six-pole crystal lattice filter is 2.1 kHz wide at minus 6 db, and 4.2 kHz wide at minus 50 db. Frequency stability is better than 250 Hz drift in the first hour and under 100 Hz drift per hour after warmup.

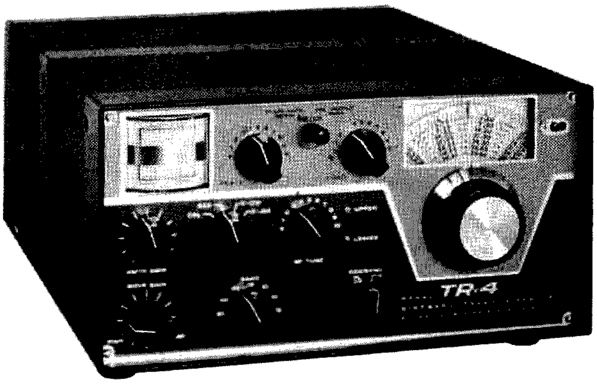
Receiver sensitivity is better than 0.3 microvolts for 10 db signal to noise ratio. Audio output is one watt maximum, and the AVC control is at least 60 db input change for 10 db change of output level. Price: $799.95 less Power Supply.

Hallicrafters SR-2000

Squeezed into a cabinet the same size as Hallicrafters' SR-400 we find a complete kilowatt-type transceiver. It tunes all the amateur bands, and runs up to 2000 watts PEP sideband or 900 watts CW.

Shown next to the transceiver is the special power supply required. This supply is probably about 50 pounds weight, and contains metering as well as a loudspeaker for the transceiver. The metering is designed for safety.

Tuning ranges and general performance are very similar to the SR-400, evidently the SR-2000's junior brother. Cost is higher, though, at $1095 for the transceiver power supply.



Drake TR-4B

Trying to get a TR-4B photo we wound up with a TR-4 instead. However, the B version is not very different. Fitted into a case 10¾" x 5½" x 14⅝" deep, this transceiver uses 20 tubes, two transistors and eight diodes. Weight is 16 pounds, external power supply required.

Transmitting specs are 300 watts PEP input to the PA in sideband operation, 260 watts CW. This transceiver can run AM, using screen modulation, with 260 watts PEP input. VOX and PTT functions are provided, and a transmitter alc circuit prevents driving the output stage into nonlinearity. For CW, there is a sidetone oscillator.

The filter shape factor is extremely good. Minus 6 db bandwidth is 2.1 kHz, and at minus 60 db the bandwidth is broadened out (if you can call it that) to 3.6 kHz, for a shape factor of 1.7:1.

Receiver sensitivity is less than 0.5 microvolt for 10 db signal to noise, and audio output is 2 watts maximum. An rf gain control also adjusts the effectiveness of the agc system, which at maximum setting can maintain the output within 3 db for a 60 db change in input signal. That is, if the input increases from 1 microvolt to one millivolt, you will just about hear the difference.

Tuning ranges cover the amateur bands 80 thru 10 meters in seven 600 kHz ranges. The solid state VFO is a linear permeability tuning design, fixed at a coverage of 4.9 to 5.5 MHz for all input frequency ranges.

An ac power supply is available at $99.95, or a 12-volt dc supply for $125. A new 24-volt dc supply has just been introduced at $210, and this one carries a 110 VAC outlet for operating accessory gear. A remote VFO and additional accessories for mobile operation are also available. Price: $599.95.

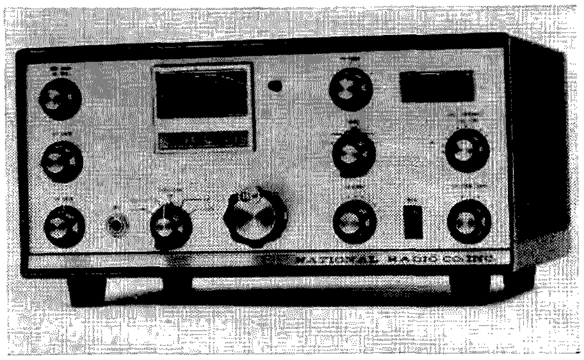
Galaxy V

That frequency scale way off to the left side of the panel looks as though it is about ready to jump off. But by all reports the users like it, and it seems to be a good arrangement for mobile work.

The Galaxy transceiver is rated at 300 watts PEP sideband or 300 watts CW. Upper or lower sideband outputs are available, with VOX operation with an accessory unit. Sideband suppression is better than 55 db, with the carrier 45 db down. Overall audio response in transmitting is down 6 db at 300 and 2400 Hz.

Receiver sensitivity is better than 0.5 microvolt for 10 db signal to noise ratio. The agc system will maintain the audio output within 6 db for a 60 db change in signal strength. Over a 40 db range, the output is essentially free from pops and pumping, and these nuisances can be avoided over any range with the help of the rf gain control.

The receiver audio output is 3 watts at low distortion into a speaker impedance of 4 to 8 ohms nominal impedance. Price is $420.00.



NCX-500

National's new NCX-500 is a surprisingly light (15 lb.) transceiver, rated at 500 watts PEP sideband, 360 watts CW or 125 watts AM. An external power supply provides for fixed or mobile operation.

Carrier suppression in the transmitter is minus 50 db, and the unwanted sideband is at least 40 db down. The transmitter is designed to work into an impedance of 40 to 60 ohms. An ALC system prevents flat-topping from noises or too-loud speech. Sideband output is Lower on 80 and 40, Upper on 20, 15 and 10 meters.

Receiver sensitivity is nominally 0.5 microvolts for a 10 db signal/noise ratio. Full AGC on receive, and audio output is 2 watts into 3.2 ohms. 5 kHz dial calibration is the same on all bands. The crystal lattice filter operates at 5.202 MHz with a 2.8 kHz bandwidth at minus 6 db, and a 2.2:1 shape factor.

The transceiver is 6³⁄₁₆" high, 13⅜" wide and 11" deep. It front panel is ⅛" extruded aluminum. The AC-500 power supply is the only one listed in National's literature but since the rig comes with a mobile mounting bracket a dc supply should be along very shortly. An accessory 100 kHz crystal calibrator is available.

Priced at $399.95, the NCX-500 is available from National Radio Co., 37 Washington St., Melrose, Mass. 02176. The AC-500 power supply, which operates from ac only, is priced at $95.00.

Collins KWM-2

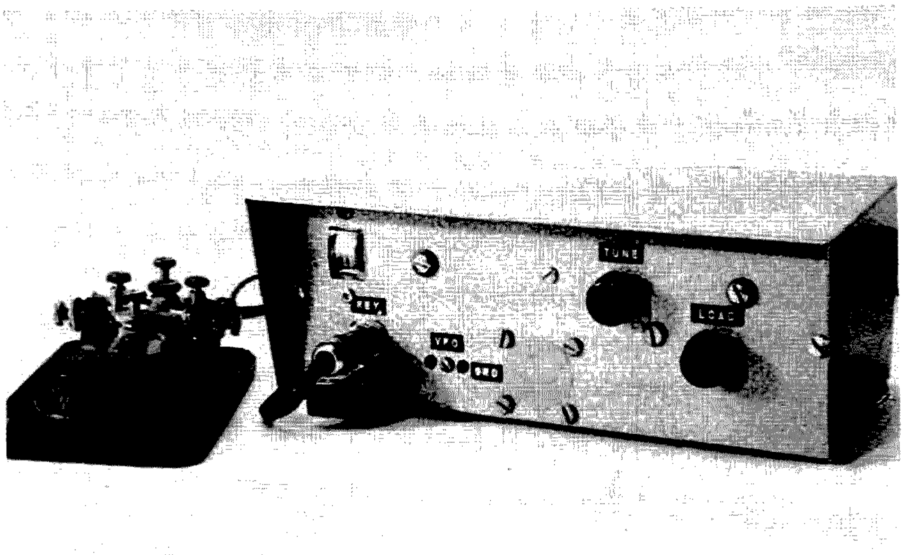
The KWM-2 comes in a 14¾" wide, 7¾" high, 14" deep case, light gray with a simulated leather front panel. Weight is 18 pounds three ounces. External power supply is required.

Frequency coverage is in 200 KHz wide tuning ranges fixed by a set of 14 crystals. As provided, the KWM-2 covers the amateur bands from 80 thru 10 meters. For commercial or MARS operations the KWM-2A carries an extra crystal board for an additional 14 ranges. Except for this modification the KWM-2A is the same as the KWM-2.

Power input to the final is 175 watts PEP sideband, 160 watts CW. There is no AM capability. Carrier and unwanted sideband are minus 50 db. Other engineering specs are equally impressive, with the help of special negative feedback design of the final amplifier.

The receiver sensitivity is 0.5 microvolt for 10 db signal to noise. Selectivity is 2.1 kHz at 6 db, 4.2 kHz at 60 db down. Image rejection is better than 50 db, receiver output 1 watt max. AGC holds audio within 20 db for a 100 db input signal change from 10 microvolts to 1 volt.

Related gear is ac external power supply, $168; dc external power supply, $235; 30L-1 linear power amplifier for 1000W PEP, $520. Price: $1150.



30 Watt Transistorized Transmitter

Roy E. Gould W5PAG
4748 DeBeers Drive
El Paso, Texas 79924

For several years I have been interested in transistorized transmitters and have read all the magazine articles I could find on the subject with interest. The first transmitters I read about were very low power, but the power has slowly been rising. The biggest problem in building a transmitter that puts out very much power has been in locating a suitable transistor for the final.

I have been disappointed until recently in finding an inexpensive transistor that can handle much power at amateur frequencies. Several months ago I learned about the Texas Instruments TIP 14, which has a 10 watt power rating and sufficient frequency response to be a good 80 meter amplifier. It doesn't cost a fortune, only $1.50. After learning of the existence of this transistor, I couldn't resist building a transmitter with a pair of them in the final.

This article describes that transmitter, a 30 watt, 80 meter CW rig. While 30 watts is not high power it is sufficient to do a good job when conditions are favorable and is relative high power for amateur band transistorized rigs. The final uses a form of π-net coupling, an unusual circuit in amateur transistorized rigs.

The circuitry

The oscillator is crystal controlled and is otherwise untuned. The circuit is simple and a major component in the circuit is the transformer. This transformer is wound on a toroid core. The primary is connected to the collector of the oscillator transistor. A feedback winding excites the crystal and the remaining secondary drives the next stage. The 47 ohm emitter resistor raises the input impedance of the stage to a level the crystal can work into easily.

The use of the toroid allows the building of a small circuit, makes tuning the stage unnecessary, and greatly reduces feedback from the final tank coil. These are important considerations when building the transmitter into a small cabinet. The cost of the toroid core is about the same as that of a tuning capacitor.

The oscillator stage can also be used as an amplifier and can be driven by a vfo. I used a Knight tube type vfo that has a no-load

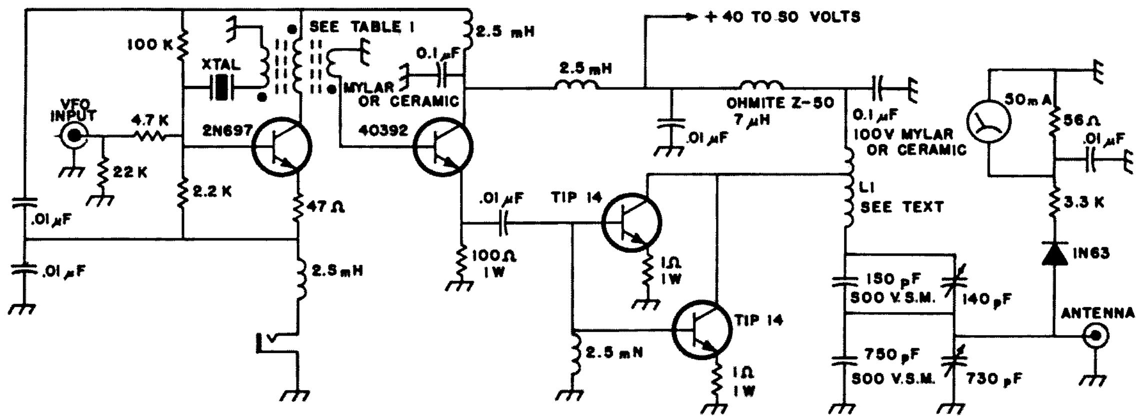


Fig. 4. Circuit diagram of the transistorized transmitter.

output voltage of 110 volts rms. The vfo voltage is fed to the base of the oscillator transistor through an attenuator network to obtain a drive voltage the stage can safely work with. The circuit works well and greatly increases the flexbility of the transmitter.

The driver stage is basically an emitter follower and isolates the oscillator from the final and drives the final from a low impedance source. The driver transistor is operated with no bias and amplifies only the positive portion of the input voltage. When there is no drive, the transistor draws no current. The stage provides no voltage gain, but does give current gain.

The final amplifier is a parallel class-C amplifier. The collectors and bases of the two TIP 14's are connected together but the emitters go to ground through 1 ohm resistors. The main purpose of these resistors is to divide the collector currents evenly between the two transistors. This helps to minimize the effect of using two transistors whose gains are far from equal.

The rfc provides a dc connection to ground for the base circuit of the final transistors, placing a small reverse bias on the final transistors. Since transistors don't conduct unless base current flows, no collector current will flow unless drive is applied

Proper tuning is indicated by an rf voltmeter. The rf voltage is rectified and the pulsating dc is applied to the tuning meter through a resistive voltage divider. Proper tuning is indicated by maximum indication on the meter.

The Texas Instruments TIP 14 transistor is ideal for use in an 80 meter power amplifier because it has a minimum f_t of 40 MHz and has a power rating of 10 watts up to a temperature of 75°C. It is further attractive because it costs only $1.50.

Since the TIP 14 is rated at 10 watts up to a temperature of 75°C, it can handle more power than most transistors with a 10 watt rating. This is because most transistors are rated at their maximum power level at 25°C (room temperature). Above this temperature, the power rating of the transistor decreases. Because the transistor ordinarily has to be above room temperature to get rid of the power it is dissipating, its power rating is reduced. The TIP 14 need not suffer any decrease in power rating because with a good heat sink, its temperature can be kept below 75°C.

The combined power dissipation rating of the two TIP 14's used in the final is 20 watts, and if the efficiency of the final were 50 percent, the power input to the final could be 40 watts without exceeding the power rating of the transistors. In a breadboard circuit, the power output from the final was measured to be slightly over 19 watts and the power input was nearly 40 watts. The transmitter described in this article cannot deliver that much power because there is not enough drive for the final. The breadboarded driver circuit would not work in the small cabinet used because the transmitter oscillated severely in the close quarters. A different driver circuit was devised and it cannot drive the final to full output.

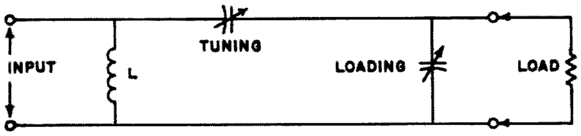
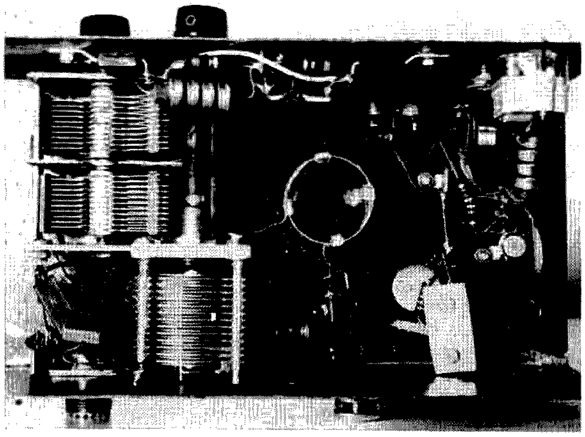


Figure 2. Basic π-network used as the final tank circuit.

The tank

Perhaps the largest stumbling block for the designer of transistorized transmitters is the requirement that the final must operate into a relatively low impedance load if a very large amount of power is to be obtained. Tank circuits conventionally used in tube circuits are not practical because very large values of capacitance and low values of inductance are required if a tank with a low input impedance is to be obtained. The often used π-net in its common form could provide the required impedance transformation but is not very practical because very large tuning capacitors in the 0.01 μF range are required. Two π-nets could be used back to back but this is not very handy because three controls would be required. The usual tank used by amateurs is a simple L-C circuit with two taps on the coil; one for the final and one for the antenna. This works but has the disadvantage of requiring an antenna tuner or of finding the proper tap points by trial and error for the antenna to provide a proper load.

I have always liked the π-net as the tank and coupling circuit for final amplifiers because of its flexibility and ability to adjust to changing loads. Therefore, I tried to design a π-network that would work with transistors. The basic π-net circuit I used is shown in **Fig. 2.** The basic difference between this circuit and the one normally used for tubes is that the input element is the inductor and the horizontal element is the capacitor. The input impedance across the inductor is high but a tap near the bottom of the coil provides the impedance transformation needed to match the load to the transistor.



Top view of the inside of the transmitter. The tuning capacitor is mounted on the top and back of the loading capacitor and the tank coil is glued to four plastic mounting rods.

The π-net used in this rig was designed to match 5000 ohms across the inductor to a resistive load of between 25 and 100 ohms. The coil is tapped near the bottom of the coil at a point which presents a load of 30 to 40 ohms to the final transistors. The tank is designed to have a Q of 15.

A tank using the same circuit could be used with tubes but ordinarily wouldn't be because there is no advantage over the conventional circuit, and the tuning capacitor has to be isolated from ground. Isolating the tuning capacitor from ground is not really a serious disadvantage however, and creates a problem mainly in mounting the capacitor.

Construction

Good high frequency construction techniques should be used. The oscillator circuitry should be separated from the final tank coil as far as possible to avoid unwanted oscillations. A wire connection should be used between ground points rather than relying upon the chassis connection. All bypass capacitors are disc ceramics except the 0.1 μF capacitors which are made with Mylar.

The tuning capacitor must be electrically insulated from ground. The section of this capacitor that is connected to the shaft should be connected to the high side of the loading capacitor because the voltage at this point is not high. Preferably, the shaft should be insulated from the knob.

The oscillator transistor does not require a heat sink, but the driver and final transistors do. The driver transistor is easy to heat sink because its case has a mounting flange. I bolted a piece of aluminum to the top of this transistor using silicone grease to increase heat transfer. The TIP 14 transistors are easy to mount with one screw. They are encased in plastic and are mounted with a mounting tab which also provides the connection to the heat sink. This tab is in electrical contact with the collector and must

be insulated from the cabinet on which it is mounted. I mounted the two final transistors on the inside of the front panel using mica and silicon grease. One reason I mounted them on the front panel was to make it easy to test their temperature with a finger. With the low voltages used there is no shock hazard, but slight rf burns can occur. (Don't touch the mounting screws when the key is down.

The transformer used in the oscillator is wound on ⅜ inch diameter toroid core. Winding data for this transformer is given in Table 1. The transformer must be connected with the polarity indicated in **Fig. 1** if the oscillator is to operate properly.

The final tank coil, L_1, was made from a one inch diameter Miniductor with 16 turns per inch. The coil has 29 turns and the final transistors connect to a tap 3½ turns from the bottom of the coil.

Table 1
Toroid Transformer Data

Winding	No. of Turn	Wire Size
Primary	16	26
Output	9	32
Feedback	14	32

Most of the parts used should be easy to obtain, however, the RCA 40392 transistor, the toroid core and the TIP 14 transistors may be difficult to obtain locally. All are listed in the *Newark Electronics Corporation Catalog No. 68*. The 40392 costs 91 cents, the TIP 14 costs $1.50 and the toroid core costs $1.20. The ⅜ inch diameter toroid core is manufactured by the Indiana General Corporation and is made of Q-1 material.

I built the transmitter except for the power supply in a 3 x 4 x 8 inch Bud Mini-Cowl cabinet. There is plenty of room in this

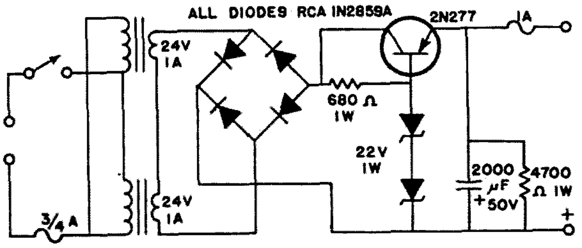


Figure 3. Schematic diagram of the power supply.

cabinet although the construction is fairly compact. The final tuning capacitor is mounted on the back of the loading capacitor. Since a shaft extension was needed, I used a piece of polystyrene rod for the extension, which insulated the knob from the *rf*.

The oscillator and driver stage could be built on a printed circuit board or on a vector board, but I used two, five terminal strips to build these sections. There are not many connections and this is an easy way to build the circuits. Most of the components in the final are mounted to the cabinet and a two terminal strip was required to wire this section.

The power supply

The power supply uses two 24 volt filament transformers with the secondaries connected in series. The secondary voltage is rectified by four diodes in a bridge. The voltage is then regulated by the transistor, whose reference voltage is fixed by the Zener diodes. The voltage is then filtered by the 2000 μF capacitor.

The power supply works well and the regulation is good. The Zener diodes I used are actually a litter higher in breakdown voltage than their rating indicate, and the no-load output voltage is 47 volts. The output voltage with a 1 ampere load current is 43.5 volts and the percent ripple at this current is 1.4 percent.

The construction of the power supply is not critical. The main problem is getting the secondaries in series so that their voltages add. If the voltage from the two secondaries in series is nearly zero, reverse the connection to one winding.

Operation

The transmitter should be connected to a fairly well regulated power supply capable of delivering 40 to 50 volts at 1 ampere. The transistors have 60 volt ratings so don't apply over 60 volts under any circumstances. The dc from the power supply should be fused with a 1 ampere fast blow fuse to protect the final.

A ground and a good antenna, preferably a half-wave dipole, should be connected to the transmitter. Even though the final uses π-net coupling, it cannot match badly mismatched loads. If a badly mismatched load is to be matched, an external antenna tuner can be used or the tap on the final tank coil could be changed.

An active 80 meter crystal should be plugged into the crystal socket or a vfo into the vfo socket. Most crystals should operate satisfactorily in the circuit. If a vfo is to be used, its no-load output voltage should be near 110 volts rms. If it is much diffierent than 110 volts, the value of the series resistor in the attenuator network (4.7 KΩ on the circuit diagram) may need to be changed. If there is too much drive, increase its value; if there is not enough, decrease it.

The only controls on the transmitter are the final tuning control and the loading control. The final should be loaded by first completely closing the loading capacitor. Then tap the key and turn the tuning knob until maximum voltage is indicated on the tuning meter. Then turn the loading control until maximum voltage is indicated, followed by again peaking the voltage with the tuning control. After the maximum voltage indication has been obtained by alternately adjusting the tuning and loading knobs, the rig should be ready to operate.

The power input to the final can be determined by measuring the input power to the entire transmitter and subtracting 4 watts, the approximate amount of power consumed by the oscillator and the driver. The efficiency of the final is about 50 percent, so the output is about one-half the input power.

Final comments

This is not a high powered rig, but it has been a good performer for me. I used it with a quarter-wave antenna about 20 feet high. My best DX was with a station in Washington state, an airline distance of about 1500 miles. It should do as well for you.

. . . W5PAG

Acknowledgement

The author is indebted to Mr. Brice for taking the photographs.

The Care and Feeding of a Ham Club—VI

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Do Something Different!

Variety is the spice of radio club life, and some of the country's most active groups credit their successes to their special projects. The Stuyvesant High School Radio Club, for instance, distributes "The Groundwave," a publication acquainting over 1000 area residents with accomplishments in the electronics field.

The RAMS of California decided to equip its members with as many hand-held transceiver type emergency units as possible. They also assisted an invalid boy in getting his novice license and setting up a station. Since there are countless hams around the country who cannot see or move about to erect antennas, construct equipment, or maintain it, one of the most worth-while projects a club can choose is to aid a handicapped ham in keeping his station in running order.

Volumes could and should be written about groups such as the San Gabriel Valley California club who developed a satellite tracking receiver in 1957 which was nationally recognized. The receiver design incorporated a principle which was soon being used by U.S. tracking stations.

Along this same line, club participation in satellite tracking and high frequency communication offers the ultimate in electronic adventure. Information on transmitters, receivers, antennas, frequencies, and all the necessary scoop is available from the American Radio Relay League, Newington, Connecticut. Project Oscar (Orbiting Satellite Carrying Amateur Radio) launched December 12, 1961, was a grand chance for a club to listen with collective ears for the fading HI it sent on its orbits.

Back to earth, there are smaller projects to be undertaken that are just as rewarding. Club stations can be constructed, permanent antenna installations completed, emergency power plants set up, trouble-shooting gear bought, and other jobs that are too big for one but just perfect for many.

And as a strictly-for-fun project, the Possum-Trotters, a club with headquarters at Paris, Illinois, bought matching hamfest shirts in bright yellow for every ham and family member from baby to grandpa. Every summer, they pack picnics and "caravan" together to hamfests.

Whether it's big or small, pick a project and see the club light up!

Double "Trouble"

If your club has a high percentage of "live wires" and an extra portion of pep, why not sponsor a hamfest or a convention some time? Sure, either one takes a lot of work, but it can also be fun. And just in case you're thinking you need a hundred members to try something big, take a look at the Starved Rock Radio Club of Ottawa, Illinois. Here in the Midwest scarcely more than a dozen hams put on a hamfest every June for over 5000 persons. Admittedly, the more workers the easier the job, but the point is that a tiny club can sponsor either a hamfest or a convention if they put their minds and shoulders to it.

A convention can be called more of a white shirt and tie affair while a hamfest is a shirt sleeve gathering with families and picnic baskets in the great out-of-doors. Weather, of course, is a very vital factor at a hamfest while a convention is usually held in a hotel and lasts two or three days requiring an hour by hour schedule of forums, lectures, exhibits, luncheons, banquets, and speakers.

Aside from these basic differences, much of the same planning goes into both events. For instance, most of the committee chairmen, listed below, would also be needed to promote a hamfest:

General Chairman
Vice-Chairman
Publicity
AREC and RACES
ARRL Booth
Exhibit Manager
Finance
Ladies Program
Awards Booth
Registrations
Mobile Judging
Hidden Transmitter Hunt
Hospitality
Programming
Parking

If you and your club are "newcomers" in the sponsoring "game," it's good to take a look at other clubs. Hit the road for every hamfest and convention you can find. Take a notebook along and jot down ideas you like and those you don't. Whoever said to profit by other's mistakes must have planned a hamfest.

The Dayton Hamvention and many other large gatherings are held year after year resulting in committees of cool-headed veterans who can meet any emergency. But, for the most part, conventions are sponsored once-in-a-blue-moon by a group or council of clubs. Enlisting the help of ten or twenty clubs and coordinating all the volunteers is a challenge; in fact, the General Chairman has to be a "miracle worker" to organize all the groups and come up with cooperation.

A small club actually has the advantage here because all the members know each other. Around a metropolitan area, there are so many hams that few are well-acquainted, and the General Chairman has to introduce his helpers right off the bat.

The first big machine to roll is pushed by the publicity people since hams have to know before they go. Individual mailings may be expensive but they're vital in order to get dates and rates around. Notices in magazines and signs erected at events earlier in the year are effective with last minute mailings to jog an absent minded ham's mind.

George Griffis, K7EIS, was Promotion Chairman of the ARRL's 25th Annual Convention September 1, 2, and 3, 1962 at Portland, Oregon. Knee-deep in planning, he reports that a skeleton group of eight men

were carrying the ball there. Starting at the top is an Executive Chairman, then the Council Chairman of radio clubs in the Portland area, with Chairmen of Registration, Promotion, Program, Finance, and Entertainment and a Convention Manager, too. Behind the scenes are dozens of assistants and just as many patient XYL' who spent many a lonesome evening and probably wound up at the registration desk or working on the women's program.

Decisions by the hundreds face the folks who organize hamfests and conventions, and since at least 75 per cent of them involve money, the first thing to do is get financial feet on the floor. Ideally, the committee should strive to keep prices as low as possible—not only for registrants but for manufacturers who sign up for booths and exhibits. Money doesn't grow on anybody's tree not even the fellow who represents the hottest selling rig in the country. Sure, manufacturers make hay among crowds of prospective check-writers, but let's face it, they have a load of expenses for transportation, meals, tips, rooms, and you-name-it. Since no big affair is complete without exhibits of new and surplus equipment, it seems only fair that factory reps and their budgets should be handled with kid gloves.

Along this same dollar-sign line is the price of registration. "The lower the better," most hams agree, but obviously a convention held at a hotel where minimum payments must be made, come rain or shine, will cost more than a hamfest held in an open pasture. Those who like conventions and can attend them regularly expect to pay, but if entrance fees can be kept down, a greater number of hams will probably flock in to enjoy the exhibits and forums. The treasurer may get nervous about the lower charges, but not when he finds himself opening the cash drawer twice as often to take in registrations.

Prizes, of course, are a "must" and two important points to ponder are (1) how to get 'em and (2) how to get rid of 'em. Practically every manufacturer or businessman in the electronics game is prepared to donate a raft of prizes every year or offer some kind of "mark-down" on new equipment. It's up to the committee to decide whether to put all the eggs in one basket and give a complete station as first prize or to buy lots of small prizes to accompany the

donations. Unless you have personally waltzed out of a convention or hamfest with a $1000 prize, you'll probably agree that the more prizes awarded, the happier the hams involved.

It's going to take time to award a lot of loot, and many prize chairmen advocate hourly drawings to get rid of small prizes, saving the big stuff until last. This eliminates a three hour drawing of log books, single tubes, and screw drivers while an antsy audience boils in the sunshine or fidgets about getting the suitcases out of the hotel room before check-out time.

Anyone who's been through the mill will tell you that it would take at least ten volumes to describe every phase of planning for a hamfest or convention. And, beside that, the best way to learn is to get into the swim of things. In short, if you and your club aren't afraid of hard work, late hours, and last minute jitters followed by feelings of real accomplishment and wonderful memories, take some advice from our astronauts, and GO! . . . W5NQQ

Getting Your Higher Class License

Part IX—More on Transmitters

Much of the technical content of all our license exams deals with the proper adjustment and operation of transmitters. This month, we'll wrap up the last of three installments covering the Advanced Class transmitter-oriented questions.

The specific questions we're covering this time are as follows (numbers, as always, are those from the FCC study list):

28. How does a full-wave bridge rectifier operate? What is the schematic diagram of this rectifier circuit?
43. Define frequency deviation in FM transmission.
49. How should a linear amplifier be adjusted for linear operation?
50. How is the power output of a 100-percent modulated AM signal related to the carrier power?
51. Why does a type 6146 tube have three prongs connected to the cathode?

As you can see, this is somewhat of a Mulligan stew of subject matter; the power-supply question could just as easily have been discussed under the heading of "receivers" and the remaining ones include design, adjustment, and operating techniques. However, we'll try to follow our usual practice and rephrase the questions into broader ones covering not only the specific details asked in the study list but as many related points as possible.

In order to define "frequency deviation" a knowledge of all the special terms used to describe FM is necessary. Our first question thus becomes "What Terms Are Used To Describe FM and What Do They Mean?"

Adjustment of linear amplifiers is included in the answer if we ask "How Are *RF* Amplifiers Adjusted For Proper Operation?", so that becomes question number two for us.

The full-wave bridge is only one of the popular power-supply circuits. Question number three therefore is "What Are The Popular Power Supply Circuits and How Do They Work?"

Multiple cathode convertions on the 6146, again, are only one example of some of the practical problems of tube design. All can be answered if we find out "Why Are Tube Pins Connected As They Are?".

And finally, power output of an AM signal when modulated is just one of the factors involved in determining the power output of any rig. "What Is Output Power, Anyway?" wraps them all up.

Ready for our modified question list? Let's go!

What terms are used to describe FM? What do they mean? While the theoreticians insist that only two kinds of modulation are possible—amplitude and angle—those of us who must deal with the real (that is, non-mathematical) world have quite a few more kinds to keep in mind. To name only those more commonly used in hamdom, there are CW, AM, SSB, DSB, and FM.

Each of these has its own particular set of words to describe the essential characteristics of the modulation; in CW keying may be "hard" or "soft", AM may overmodulate, either type of sideband may generate "buckshot"—and FM may do almost anything.

Most of us have already learned the essential words to talk about AM, CW, and sideband just in the course of everyday operation. Unless you're an FM buff, though, the chances are good that you aren't as familiar with the FM jargon—and that's what this question is all about.

While it doesn't *really* work like this, most of us find it easiest to think about FM by visualizing a carrier of steady power being moved about in frequency by the

audio which is modulating it. The *rate* at which the carrier frequency swings is determined by the *frequency* of the audio, and the *distance* from the center frequency that it swings is determined by the *loudness*.

In this oversimplified picture, a low-frequency signal and a high-frequency signal (both audio, that is) will swing away from center equally if both are equally loud. The bass tone, though, will swing more slowly than the treble.

While an AM signal can overmodulate and cause objectionable splattering across the bands, an FM signal cannot be overmodulated at the transmitter. "Overmodulation" in FM is determined at the receiver; any time the signal swings across a wider range than the receiver can handle, it is overmodulated. For legal purposes, the equivalent of AM's overmodulation is "excessive frequency deviation"—or too wide a swing. In the bands below 52.5 MHz, maximum swing permitted is 3 kHz.

Now about those words. We've been using some of them so far. "Frequency swing" is the number of Hertz, kilohertz, or megahertz that the signal moves from one side to another. The bandwidth occupied by the signal is equal to two times its maximum frequency swing. "Frequency deviation" is the same as "frequency swing".

"Modulation index" is another term employed frequently in FM. The modulation index of an FM signal is equal to the frequency deviation divided by the modulating frequency. That is, if your audio is a 3-kHz tone and your deviation is also 3 kHz, the modulation index is 1.0. With the same deviation but a modulating frequency of 300 Hz, the modulation index is 3000/300 or 10.0.

"Modulation index" also applies to AM but is determined differently there—"modulation percentage" is simply 100 times the "modulation index" in an AM transmitter, so that the maximum modulation index permissible in AM is 1.0 and the average is more like 0.3 to 0.5. The higher modulation index attainable in FM is one of the advantages of this type of modulation.

FM is frequently divided into two classes for discussion—"wide band" and "narrow band". "Narrow band" always has a smaller modulation index (less frequency swing) than does "wide band", but beyond that the terms "wide" and "narrow" are strictly relative.

For instance, when hams talk of narrow-band FM (NBFM) they mean FM with less than 3 kHz frequency deviation or swing, as prescribed by FCC rules for operation below 52.5 MHz. In this kind of conversation, "wide band" means anything with wider deviation than 3 kHz.

But in the two-way communications industry, "wide band" means anything greater than 15 kHz or so swing, and "narrow band" is anything less. Thus a signal with 5 kHz swing would be "wide band" to a ham and yet "narrow band" to a two-way man.

It gets worse. FM broadcasting has a maximum frequency deviation of 75 kHz while TV's deviation (on the FM audio part of the TV signal is 25 kHz. The TV audio signal is sometimes called narrow-band since it is not as wide as FM broadcast. So it all depends to whom you're talking.

We've used another FM term, "center frequency", quite a bit already without defining it. That's the frequency of the carrier when no modulation is present. It gets its name because it's at the "center" of the channel. Frequency deviation is to both sides of the center frequency. If your center frequency is 50.055 MHz, for instance, and you are using 3 kHz deviation, your signal may swing from a low of 50.052 to a high of 50.058 MHz as it is modulated.

The final important term in FM is "threshold"; FM signals have a special characteristic not found with any other type of modulation. When they're strong enough, they actually take over and suppress background noise. They even suppress any interfering signals on the same channel. Up until the FM signal is strong enough to exercise this "capture effect", though, you can't even find it.

The signal strength at which the signal is "strong enough" is known as the "threshold" of the signal. It is determined almost exclusively by the modulation index of the signal. The greater the modulation index, the greater the signal you must have to reach the threshold—but the greater will be the noise suppression, once the threshold is reached.

For illustration, if an FM signal has a

modulation index of 1 (such as a ham NBFM signal), the signal must be about 3 db above the background noise for the threshold to be reached. By the time the signal is 4 db above noise, capture effect has cut in and the noise is reduced another 4 db. This gives an 8 db signal-to-noise ratio, twice as good as that provided by the signal alone.

If, however, that same signal had been a ham WBFM signal with modulation index of 4, it would have had to be at least 10 db above the noise level to reach the threshold. The improvement, however, would have been almost 15 db instead of just 4—so that the received signal would be 25 db above received noise instead of merely 10 db. The total signal-noise ratio, in this case, is 3 times better than that for the NBFM signal.

How are rf amplifiers adjusted for proper operation? Like any other amplifier, an *rf* amplifier consists of three major portions—the input circuit, the amplifier itself, and the output circuit. To operate properly, all three of these portions must be functioning as the designer intended.

The adjustments available to us as operators, though, normally affect only two of the three portions. The amplifier itself usually has no adjustments which we can readily reach (although in some cases, bias on the amplifier tube is adjustable). Operating adjustments—for any *rf* amplifier, linear or not—are usually limited to those for drive, tuning, and loading. The drive adjustment is a part of the input circuit, while tuning and loading are in the output circuit.

All *rf* amplifiers must be properly tuned in order to operate. This is accomplished, as you probably are aware, by applying a steady input signal and tuning for a pronounced "dip" in final plate current. The only critical point here is to be certain that the amplifier is tuned to the desired frequency rather than to some unwanted harmonic of the input signal—and that's a relatively easy check to make.

The differences in adjustments for the different kinds of amplifiers (CW, modulated AM, linear AM, or sideband linear) show up most prominently in the drive and loading controls, although loading and tuning adjustment do interact with each other. Before we look at the details of these adjustments, let's examine again how any such amplifier works.

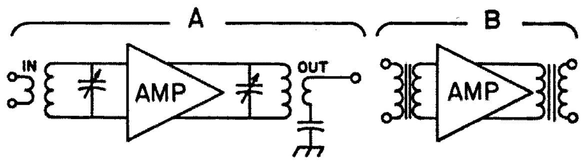


Fig. 1. A typical rf amplifier circuit is shown at left; Audio equivalent at right. Adjustments are drive (input circuit), tuning (output circuit), and loading (indicated).

Fig 1 shows a block diagram of a typical *rf* amplifier. This may be a linear, a CW final, or a high-level modulated unit; it makes no difference. In fact, you could even replace the input and output tank circuits with transformers as shown in **Fig. 1B** and it would be a good audio amplifier (if the tube voltages were properly chosen).

The tube amplifies the signal, by using the grid *voltage* to control plate *current*. The particular class of amplification (A, B, or C) and a major portion of the amplifier's linearity as well will be determined by the voltages applied to the tube.

The input circuit's main job is to provide the desired amount of voltage swing to the grid of the tube. Depending upon the amplifier design, this circuit may have to transform "power" input into voltage for the grid, or it may merely have to transform the voltage to a higher or a lower level than that swing provided by the preceding stage.

The output circuit has many jobs, but we'll concentrate on only one: it provides the "transformer" action necessary to convert the plate current swing into *rf* power at the right impedance level to feed our antenna line. This normally involves an impedance step-down, just as an audio amplifier ends up at a transformer which steps the output tube's impedance down to match a speaker's voice coil.

When this step-down is correct, the output circuit provides a "load" for the tube—and the choice of voltages for the tube depends in part upon the load seen by the tube. Thus all three major parts of this circuit interact with each other, and no one can operate properly unless both the others are also in the right ball park at least.

An audio amplifier is a broad-band device; the average stereo console amplifier handles a frequency range from below 50

Hz up to at least 15 kHz, which is a 300-to-1 ratio. *rf* power amplifiers, on the other hand, are all relatively narrow-band. Even a "broad-band" final which would cover 80 through 10 meters without retuning would be covering only a 10-to-1 frequency ratio. And the average final tuned to, say, 3900 kHz is covering only about a 3 kHz bandwidth, for a 1-in-1300 ratio of bandwidth to frequency.

The broad-banded audio amplifier requires a specially designed transformer to provide its output circuit. Handling *rf* as we do, we get out more easily. A simple tuned circuit, if properly adjusted, does the impedance transformation for us. One of the "proper" adjustments, though, is the tuning. The other one is the "loading" adjustment, which actually adjusts the coupling between the amplifier and the antenna. The effect is to change the transformation ratio of the output circuit.

The tube's load, provided by the output circuit, is electrically the same as a large resistor. Adjustment of the "loading" controls varies the effective resistance. The lighter the loading, the higher the effective resistance. With higher resistance, less plate current flows and the "dip" when tuning is extremely deep.

The higher resistance also, though, means less power can be transferred through the circuit—or even produced by the tube in the first place. With light loading, the tube is virtually loafing along and little power is delivered to the antenna. This is bad for any *rf* amplifier because all that *potential* power's energy is still wandering around the rig in the form of excessively high voltage swings, and sparks may be expected at the very least.

As loading is made heavier by increasing the adjustment of the loading control, the effective resistance of the output circuit goes down. As the resistance drops, more plate current flows. The additional plate current is able to produce more power by using that high-voltage energy, and the increased coupling which increased the loading in the first place permits more of that extra power to flow out to the antenna.

With a normal class C amplifier (non-linear), standard practice is to crank up grid drive until rated grid current flows, tune the final for the dip which indicates that it is tuned to proper frequency, and increase loading until the desired amount of plate current is indicated on the meter (taking care that the tuning remains correct, since a change of loading will affect the tuning adjustment also).

If you're going all out for maximum power, you may keep on cranking up the loading until the "dip" is virtually undetectable in the belief that this is producing maximum output.

Unfortunately, when you get the effective resistance of the output circuit down to a much lower value than the designer intended in the first place, the amplifier actually puts out *less* power—although it continues to draw more and more current, as you would expect with less resistance. This too is a condition to avoid; the extra current isn't going to the antenna, but is merely trying to melt out your rig!

If maximum power output is your goal, you must have some type of relative power indicator to tell how much is actually getting out. This can be anything from a SWR bridge in the feedline to a field-strength meter—or even a pilot bulb coupled to the feedline, not to the final tank where it won't tell you nearly as much. Then increase loading so long as the power output keeps climbing—and stop!

Drive, the third adjustment, is relatively uncritical in a class C rig. The only requirement is that there be enough of it. Good operating practice indicates that there should *not* be an excess of drive, which will increase the chances of harmonic problems. The grid-current ratings, though, are not Gospels. Once the rig is tuned and loaded properly, drive can be reduced until a reduction in power output is just detectable, and then increased about 20% above this point. For CW use, no increase is necessary. If the rig is modulated, though, additional drive is advisable in order to have a reserve on hand for peaks of modulation.

So far we've looked at the three adjustments for non-linear amplifiers. What happens to them if we are trying to be linear instead?

Tuning remains pretty much the same, if we keep in mind that the permissible operating range of the tube is much more critical for linear than for non-linear use. If the amplifier is properly designed, though, this factor will already be taken care of.

Loading is much more critical. Either under-loading or over-loading in the output

circuit of a linear leads directly to distortion.

Drive adjustment also is much more critical. Under-drive is no problem, but excessive drive will lead directly to severe distortion and splattering. Let's look at these two adjustments more closely.

When a linear amplifier is not loaded heavily enough, the effective resistance of the output circuit is too high. At very low levels of input signal this has no harmful effect—but as the input signal increases during transmission of even a single syllable of speech, the too-high resistance sets a limit beyond which output signal cannot climb.

The result is peak clipping, which generates splatter all over the bands and can even put the suppressed sideband back onto the signal.

As the load increases, by adjusting for tighter coupling to the antenna, the effective resistance of the output circuit decreases. When it gets to the point at which the amplifier circuit was designed to operate as a linear, the maximum output power is developed and distortion is minimum.

Increasing loading still more reduces output but does not add significant distortion until the over-loading is severe. Usually the tube is damaged by excessive power dissipation by the time this point is reached.

Distortion is still present in an amplifier which is too heavily loaded, although it is not so severe as in one which is underloaded. The distortion created by too-heavy loading is more usually in the form of intermodulation or "third-order" distortion, which is not so obvious when listening to the desired output signal but which does put back in parts of the sideband you went to such trouble to get rid of in the first place.

While the loading of a non-linear amplifier can be checked quite easily by means of an output-power indicator, that of a linear amplifier virtually requires oscilloscope measurements of the signal. We'll go into this a little later, since most improper operation of linears is due to maladjustment of the drive rather than of loading.

The drive adjustments are probably the most critical ones in adjustment of a linear amplifier. Excessive drive in a linear is a sure way to generate a lousy and illegal signal.

The idea, in adjusting drive to a linear, is to provide *enough* drive for the amplifier to operate properly yet not provide *too much*. Since a linear's input signal may be anything from no signal at all up to the maximum permitted by the drive adjustments, the condition of "too little" drive simply cannot exist. All the adjustments have to do with setting an upper limit beyond which drive cannot go.

In the initial adjustment of a linear rig, each stage from the exciter on out to the final must be adjusted individually. Only after the lowest-power stage in the rig is operating properly can you move on to the next stage toward the antenna. Of course, if you're adjusting a factory designed and built unit, most of this will have already been done for you.

In each stage, the drive must be adjusted so that enough is available to drive that stage to the full rated undistorted output, without driving it over the limit into distortion. Once distortion is put into the signal, at any stage, getting it back out is like trying to remove one piece of solder from the middle of a molten blob on the bench!

In many rigs, the output circuit for one stage is a part of the input circuit of the next. In these cases, the loading control for the first stage is the drive control for the second, and so forth.

With such rigs, the "drive" control employed for final operator adjustment is usually the audio gain control on the exciter. To tune such a unit up—and the same practice can be employed for any linear amplifier—first apply an audio signal a little stronger than your mike can ever develop to the mike jack and ascertain that the audio amplifiers in the exciter can handle this signal without distortion.

When the exciter is adjusted to produce undistorted output from such an input signal, connect the exciter to the linear amplifier and adjust the linear one stage at a time until each, in turn, is producing its rated output—still without distortion.

Should any stage prove incapable of producing its expected output, check that stage carefully. Try adjusting the loading for that stage, as well as rechecking all previous stages.

When the entire amplifier is tuned up in this manner, it will be able to handle any signal delivered by the mike in a linear fash-

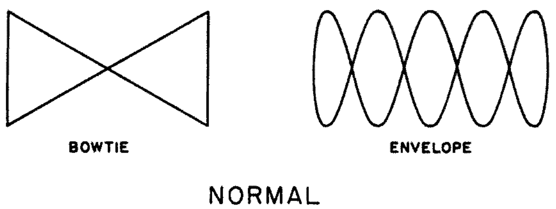


Fig. 2. Oscilloscope displays above are normal indications of linear-amplifier operating properly.

ion. Lock all the adjustments except final tuning and drive.

It should go without saying all these adjustments should be made using a dummy load, rather than with the rig actually on the air. If a legal-limit amplifier is being tuned in this fashion, it will be operating at several times the legal limit during the final stages of adjustment.

All that is now necessary to complete adjustment on the air is to retune the final and readjust final loading after connecting the antenna, to the same operating conditions. This is easiest to do if, after the initial tune-up, you reduce the audio gain until the rig is operating at about half its rated power. Note the audio gain setting and final plate current. With steady-tone audio, plate current will also be steady.

Then after connecting the antenna just apply the same input signal with the same audio gain setting, and load for the same value of plate current. The same loading conditions will automatically be established.

From this point on, the only operating adjustment is the audio gain control—which determines the drive applied to the entire rig.

To determine the proper settings, though, requires (as we mentioned earlier) a scope hooked up to view the output signal. Either an "envelope display" or "bow-tie" pattern can be used. **Fig. 2** shows the output patterns to expect from either when everything

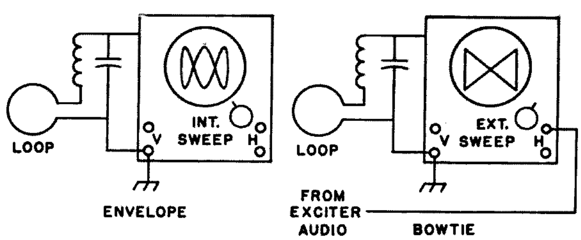


Fig. 3. Test set-ups for both types of displays. In either case, tank circuit is tuned to operating frequency and connected through a capacitor directly to vertical deflection plate of CRT.

is correct. **Fig. 3** shows the hookups for generating both types of displays. **Fig. 4** shows some of the abnormal patterns you may get with excessive drive, under-loading, or over-loading.

What are the popular power supply circuits and how do they work? Power supplies show up in many places. In this question, we aren't even considering the transistorized power supplies used for mobile work, either. But receivers, transmitters, and test equipment alike share the requirement for dc to operate—and the wall plugs provide us with ac. The power supply does the job

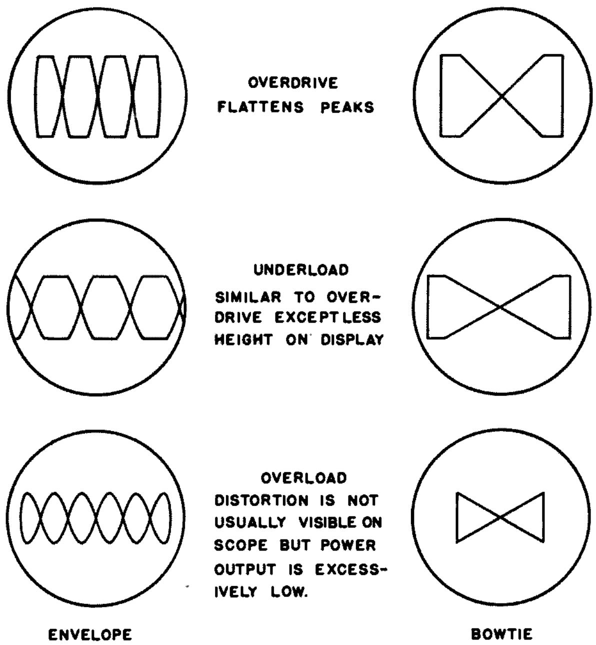


Fig. 4. Typical patterns exhibited by linear amplifier with operation not normal. Refer to SSB handbooks for more detailed views; these are to illustrate the theory involved rather than to provide an operating guide.

of changing the 115-volt 60-Hz ac from the wall plug into dc of the proper voltage and current characteristics to power our equipment.

All power supplies for this purpose employ rectifiers, either solid state (silicon diodes or selenium stacks) or tube type (vacuum tubes or mercury-vapor tubes). Most also employ transformers to adjust the voltage level although some operate directly from the power lines.

The job of the rectifier is to change ac into dc. Any individual rectifier element operates by simply blocking half of the ac waveform so that what gets through is all

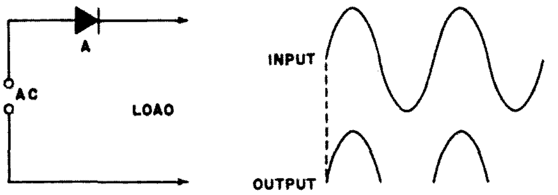


Fig. 5. Half-wave rectifier circuit and waveforms.

going the same direction—and this accomplishes the change. The resulting dc, although still pulsating at a rate related to the frequency of the original ac, is all going the same way. The filter circuit then smooths out the pulsations to provide "pure" dc for our devices.

While any individual rectifier merely blocks half the ac waveform, rectifier *circuits* are divided into two classes called "half-wave" and "full-wave" respectively.

The half-wave circuits operate just like the individual rectifier; they let half of the ac wave through and hold back the other half.

The full-wave circuits, though, contain several rectifier elements. These circuits *steer* the ac waveform through one or the other of the rectifier elements, so that both halves of the waveform come out as dc going in the same direction. Since they use the full waveform, they are called full-wave circuits.

The most common full-wave circuit cheats a little by using a center-tapped transformer to reverse the direction of the ac current flow. Only half of the transformer is in use during any half-cycle, and the rectifiers determine which half this is.

Fig. 5 shows the operation of this circuit, in comparison to the half-wave circuit in **Fig. 6.** You can see that the circuits are most similar. In both, rectifier A begins to conduct at the point marked "1" in the waveforms and conducts until the point marked "2". When time "2" is reached, rectifier A begins blocking current flow. In the half-wave circuit, no current flows again until time "3". In the full-wave circuit, rectifier B begins to conduct at time "2" and conducts until time "3". However, rectifier B is connected to the other side of the transformer center-tap, and the circuit's electrical return path is through the center tap. Thus the transformer is effectively turned end-for-end at time 2, and back to its original position at time 3. Both halves of the input ac are used—but only half the transformer is in use at any given instant.

With the advent of the solid-state rectifier, a different type of full-wave circuit has come into popularity. (With vacuum tubes, the circuit requires separate transformers for the rectifier filaments and so was used only rarely.) This is the bridge circuit shown in **Fig. 7.**

The major advantage of the bridge circuit as compared to the older full-wave circuit of **Fig. 5** is that the full, transformer secondary is used at all times. It also permits full-wave rectification without requiring a transformer. The bridge circuit operates entirely by "steering" current flow.

For instance, at the point marked "1" in the waveforms both rectifiers A and C can conduct while rectifiers B and D are blocked. This condition continues until time "2", and so current flows out of the bridge as indicated by the arrow.

At time 2, the polarity of the ac input reverses. This blocks rectifiers A and C, but permits rectifiers B and D to conduct. Current out of the bridge still flows in the same direction.

At time 3, the ac polarity reverses again and returns to the same condition that existed at time 1. You can see that the full ac cycle is steered through to the load, but is always flowing in the same direction when it reaches the load circuit. For half a cycle it flows through rectifiers A and C, and for the other half through rectifiers B and D.

Most tube-type receivers use either the full-wave circuit of **Fig. 5** or the half-wave circuit of **Fig. 6** (if they are inexpensive receivers without a power transformer). Solid-state equipment, on the other hand, employs the bridge almost exclusively. Transmitter power supplies almost invariable use full-wave rectification because it is more efficient and is also easier to filter into "pure" dc required by law. The choice between bridge and center-tap circuits is about even, though, with medium-power rigs more likely to use the bridge and high-power equipment usually using center-tap circuits together with mercury-vapor rectifier tubes.

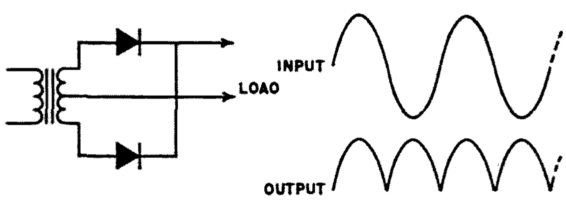


Fig. 6. Full-wave circuit and waveforms.

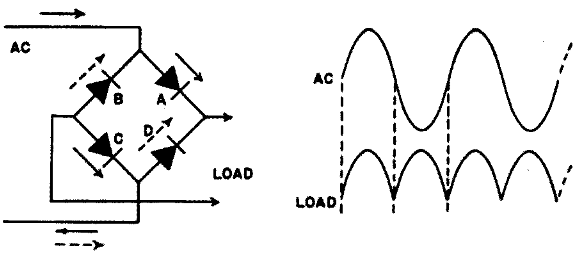


Fig. 7. Full-wave bridge circuit and waveforms.

Why are tube pins connected as they are? The earliest vacuum tubes had only four pins—two for the filament, and one each for the grid and the plate. Many modern tubes have many more pins, but no more elements—and yet every pin is connected to an element. A 9-pin miniature receiving triode for VHF amplifier use, for instance, may have two of its nine pins connected to the filament, one to the plate, three to the grid, and the remaining three to the cathode.

A single wire suffices to make electrical contact between two points. Why, then are tubes built with two, three, or even four pins connected to the same internal elements?

Manufacturers design tubes this way for two major reasons. Both reasons have to do with high-frequency performance.

Multiple grid pins are most frequently found in tubes intended to be used as grounded-grid amplifiers at VHF. In such an application, it's important that the grid actually be at ground for the *rf* as well as for dc. In fact, there's really no need for a dc ground so long as the grid is completely grounded for the *rf*—and some circuits are so designed.

And while a single wire suffices to make electrical contact between two points so far as dc is concerned, it may *not* do so for *rf*.

Any wire has a certain amount of inductance, even if it's not bent into a coil. To high-frequency *rf*, this inductance acts about the same way a resistor does to dc. A single wire, if it has great enough inductance, *doesn't* make proper electrical contact.

The inductance can be reduced by shortening the wire's length, or by using larger wire. In a tube, though, both the length of the wire and its maximum diameter are fixed by mechanical considerations. A limit is soon reached, for any particular tube design, beyond which the inductance of each lead cannot be reduced.

Three resistors connected in parallel will have only one-third the resistance of each one individually (if all are of the same value). Similarly, three separate leads connected in parallel will have one-third the effective inductance of one.

Thus by using more than one lead, with a separate pin for each, the tube designer can reduce the inductance between the actual tube element and the point outside the tube to which it is connected.

That's one of the reasons. Associated with this reason is a sub-reason: In any circuit using a vacuum tube, the reference "ground" point for the circuit's current flow is *not* the equipment chassis. Instead, it is the tube's cathode. All plate and/or grid current must flow through the cathode surface.

Since the cathode must be in vacuum inside the tube, though, you can't get to it directly to make any connections. All your connections have to be made to the tube's pins.

The inductance of the leads from the pin to the cathode itself, as we said, acts about like a resistor. When current flows through a resistor, it produces a voltage across that resistor. Similarly, when *rf* flows through an inductor it produces a voltage across that inductor—even if the inductor is a length of wire inside the tube.

Modern amplifier tubes have extremely high gain. A very small signal in the grid circuit is amplified into a rather large signal in the plate circuit.

The cathode's surface is in both the grid and the plate circuits. This cannot be avoided. If both the grid and the plate external circuits return to the cathode by way of the same tube pin, then the inductance of the lead from cathode surface to pin is also in both the grid and the plate circuits.

And when the amplified signal in the plate circuit flows through this inductance, the resulting voltage is automatically in the grid circuit as well. The result—feedback and possible oscillation (see Part III of this series for more on this).

By using two or more separate pins, each with its own leads, from the cathode to the rest of the circuit, the lead inductance can be kept effectively out of the picture. With the grid circuit returning to one pin

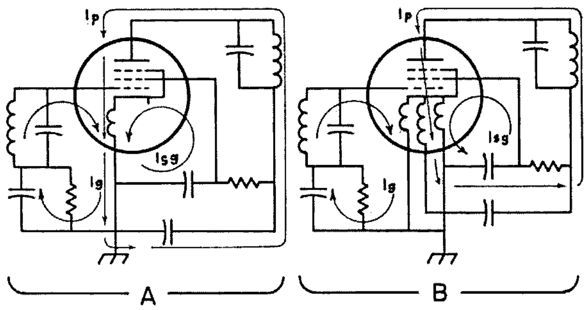


Fig. 8. Multiple pins are used in modern tubes to provide separate paths for input and output circuits involving same element. A shows only one cathode pin is available, so grid, plate, and screen current all circulate through inductance of single cathode lead and may interact. Three separate pins in B permit the three circuits to be kept completely separate. Effect is of importance only at high frequencies.

and the plate circuit to the other, any voltage developed across the plate circuit's lead inductance cannot get into the grid region—and one built-in source of feedback is eliminated. This is the reason that most modern high-gain transmitting tubes provide multiple cathode connections, as in the 6146.

Fig. 8 shows this effect pictorially. The lead inductance is shown as an *rf* choke—because, as the frequency gets high enough, that's how it acts. And we learned back in Part III of the series that feedback can be effective at *any* frequency, not just at the frequency you're tuned to. The type of feedback the multiple pins are intended to eliminate is one of the primary causes of parasitic oscillation.

The other major reason for use of multiple pins also has to do with feedback, but does not involve lead inductance at all and is usually applicable to VHF receiving tubes *not* intended for grounded-grid amplifiers.

Many of these tubes have multiple cathode pins, all of which are intended to be strapped directly to ground. These pins are located on the base in positions which separate the grid, plate, and other-active-element pins. When all these pins are grounded, they form effective shields to reduce feedback between input and output circuits of the tube.

The pin arrangement on multi-section-receiving tubes is also chosen with a sharp eye toward the intended uses of the tube. Pins are usually located in such a manner that external connections can be made with the shortest possible wires. This is the reason why several types of tubes are available having identical electrical characteristics, but different pin arrangements—some are arranged for one specific circuit, and others for others.

Not all tubes, of course, even use pins for the external connections. The popular 4x150/4CX250 series of power tubes, for instance, has no plate pin; the outer shell of the tube *is* the plate and any connection is made directly to it. The older "lighthouse" tubes featured similar construction, as does the 416B UHF tube. Planar tubes carry this idea into today's designs. Again, elimination of lead inductance and shielding between input and output circuits are the primary reasons for such arrangements.

What is output power, anyway? One of the least understood quantities we'll ever deal with in radio is that known as "transmitter output power".

For instance, most of us are aware that the maximum legal *input* power to a transmitter, as indicated on the meters, is 1000 watts. It's also no secret that most transmitters are at best no more than 75% efficient at turning this input power into output power, so it would be logical to expect that the maximum legal output power would be somewhere fairly close to 750 watts.

However, it's possible to run a rig *legally* on the HF bands with as much as 4000 watts input power and corresponding 3000 watts output power with one type of modulation while another type of modulation is restricted to only 1000 watts in and 750 watts out. When you get into the VHF and UHF regions where pulse modulation is permissible, input powers on the order of 100,000 watts can be had legally. At these frequencies efficiency drops so your output probably won't exceed 50 kilowatts or so—but still!

The trick in all this lies in that innocent phase "as indicated on the meters". Even when running 100-kw peak input during pulse modulation, the meters must not exceed a 1-kw input reading. Since meters are relatively slow to react—a dc meter cannot, for instance, react rapidly enough to indicate 60-cycle ac—the meter cannot tell whether you are applying 100 kilowatts for 10 microseconds and then no power at

all for the next 990 microseconds, or are putting in a steady 1000 watts all the time.

This is not the magic trick it might appear to be; the receiver at the other end of the line is hard-pressed to tell the difference either. A 100-kw pulse signal which is present only 1 percent of the time is no more effective than a 1-kw steady signal which is always there. The advantages, if any, of pulse modulation do not lie in the field of getting extra power for nothing.

The 4-kw figure mentioned for HF bands is more of a play on words. Power, either input or output, comes in several different flavors. There is "peak" power—which may mean any of three distinctly different conditions—, "average" power, and "RMS" power.

To get an idea of the different possible meanings of the term "peak power", let's look at an ordinary 60-watt light bulb operating from normal 117-volt ac wall power.

During each cycle of the ac power, the voltage on the line rises from some negative value through zero to a positive peak, then falls back smoothly through zero to a negative peak which is a mirror image of the positive peak, and returns to its original value.

This complete cycle is repeated 60 times every second. And while we call this power "117-volt" or maybe "110 volts", its voltage is actually always changing. It is exactly 117 at only four instants during each cycle—once on the way up between zero and positive peak, once again on the way down, a third time between zero and negative peak, and the final time as it climbs from the negative peak toward zero.

The reason we call it "117-volt" power is that it will produce the same amount of heat in a resistor as would 117 volts of dc applied to the same resistor. This is the "RMS" value, and is a convenient label.

But the peak voltage of this 117-volt power line is actually about 165 volts; it reaches this voltage only twice during each cycle, and doesn't stay there any appreciable length of time either time.

Our light bulb is a resistor. The more voltage we apply to it, the more current will flow. The RMS current in a 60-watt 117-volt bulb would be 60/117 amp, or about 0.513 amps. The resistance, by Ohm's law, equals the voltage divided by the current or 117/0.513, which comes out to be about 230 ohms.

Now when we apply that "peak" voltage of 165 volts to the 230-ohm resistor which is our light bulb, we will get a "peak" current of about 1.38 amps—and when we multiply voltage by current to find out the "peak" power we discover that our "60-watt" bulb uses a peak power of 230 watts!

This is an impressive figure, sure. But the bulb doesn't give us a bit more light at peak power of 230 watts than it does at "60" watts. This is *one* meaning of "peak power", and you can see that it's not very meaningful. By this viewpoint, *any* full gallon is running 4000 watts peak input power.

This kind of peak power is sometimes called "instantaneous peak power", because it is present only for an instant at the peak of each cycle of the ac.

A more meaningful way of talking about "peak" power is to discuss "peak envelope power". This refers to the *RMS* power (or dc power, if input power is under discussion) present when the *audio* modulating signal is at its peak. Most sideband rigs are rated on PEP power.

This kind of peak power is what actually gets the signal through. The figures are much less than those for the same transmitter for "instantaneous peak power", but are higher than for "meter peak power" which we'll discuss next, or "average power". In sideband operation, PEP power is the power you get when the rig is adjusted for maximum linear output as discussed earlier in this installment.

In a FM rig, the output power does not change appreciably with modulation. In a CW rig, the power is either there or it is not. PEP power of a CW rig is the same as the key-down power; the term is almost meaningless for FM.

An AM transmitter, with carrier, is much like an FM or a key-down CW rig when nobody is talking. The carrier is still present. When you modulate, however, the audio power from the modulator is either added to, or subtracted from, the carrier power. The result is that peak envelope power is greater than the average carrier level.

Virtually all of the theory about AM modulation and its effects on power assumes modulation with a steady audio tone rather than voice, because the steady tone is a known signal and voices differ in their characteristics.

With a steady tone, and modulating the carrier to the 100-percent level, the resulting modulated signal's power will drop exactly to zero at the negative peak of the tone's cycle. In order for this to happen, the modulator's average power must be exactly half that of the carrier. On the positive peak of the tone's cycle, then, the envelope will have all the power of the carrier *plus* all the power from the modulator, and so will be half again greater than that of the carrier alone.

The peak envelope power of a 100-percent modulated AM signal—when the modulation is a steady tone—is always half again greater than the PEP of the same carrier unmodulated.

When voice is applied rather than the steady tone, the picture changes. Voices are not symmetrical; their positive peaks may be higher than their negative peaks or vice versa. The "100-percent" modulation point is defined as that amount of modulation which permits carrier power to be reduced to zero at any point in the modulating cycle. If the voice's highest peak comes out as a negative peak from the modulator, this will cause 100-percent modulation to occur with less voice loudness than if it comes out positive. In any case, the average level of the voice is far lower than those peaks—and so the 50-percent increase of power with modulation never occurs.

Now let's look at the "meter peak" power. This is simply the *highest* power indicated by the rig's meters while you're talking. Its chief importance is that *it* is the power which is regulated by the FCC, and must never exceed 1000 watts.

A properly operating AM rig will show no fluctuation at all in the meters when audio is applied, unless it's using "controlled carrier" modulation. Any flickering indicates improper modulation. The theoretical 50-percent increase in PEP is never visible on the meters, because the meters indicate only dc and the power from the modulator is ac in the audio range.

A sideband rig, on the other hand, will flicker widely with speech. So will a CW rig being keyed, or an AM rig using controlled carrier. Regulations specify that power of a CW rig be measured with key down; for the others, the requirement is simply that the meters never indicate power above the legal limit.

Next Month. We've come all this way and managed to bypass those little problems which require arithmetic, such as the calculation of series impedances or determinations of transformer turns ratios. Next month we'll explore those. Don't let the prospect scare you—nothing more complex than arithmetic is involved. Until then, happy hunting. ■

W2NSD/1 from pg 4

more difficult job of creating hypotheses which fit the data." He goes on further to say, "I have concluded that the earth is being visited by intelligently controlled vehicles whose origin is extraterrestrial."

Dr. McDonald of the University of Arizona has been studying UFO reports on an intensive basis for over two years and has interviewed several hundred witnesses. He has reluctantly come to the conclusion "that the UFOs are entirely real and we do not know what they are, because we have laughed them out of court. The possibility that these are extraterrestrial devices, that we are dealing with surveillance from some advanced technology, is a possibility I take very seriously." Dr. McDonald goes on further to say, "For the record, I should have to state that my interviewing results dispose me toward acceptance of the existance of humanoid occupants in some UFO's. I would not argue with those who say this might be the single most important element of the entire UFO puzzle."

Friends, something very definitely is up here and it looks as if a large responsibility for the expansion of investigation of the UFOs rests on the shoulders of amateur radio. With only a small amount of organizing we can be set up to provide nationwide alerting when UFOs are spotted.

Send for the free 250 page book on the Congressional Symposium and read about hundreds of virtually unarguable sighting cases . . . cases that have been exhaustively investigated. Read about hundreds of pictures and films that have been taken. See 63 UFO photographs assembled on one page.

Next comes the need for your own personal decision that you are going to try to help those interested in doing something to bring this problem out into the open. Your interest and a little time are needed to get the amateur radio UFO network built up into a 24-hour a day alerting amateur net. Amateurs who have substantial signals and will be available on the same evening week after week for about an hour of net operation should drop a card to Jim Sipprell K2HYQ, the overall net coordinator, at Box 209, Kenmore, New York. The frequency is 14.3 and the time is 0200 GMT, which is 9 PM EST.

By next spring I hope we will be ready to get everyone interested in the net set up

with an alerting system. I believe that we will use a 60-cycle calling arrangement. This will be easy to standardize. Graybar has some 60-cycle tuned relays available inexpensively which can be hooked up to the receiver and left tuned to the Net channel. They are sensative to within a half cycle so other frequencies won't bother them. When any station comes on the net channel and sends a tone which is modulated with a 60-cycle note the relay will pick up and let you know. This means that both AM and SSB stations can work together in the net.

If you feel that you are ready to become involved in something really important then join the UFO net merely by checking in on any Wednesday night. In your own area you should contact your newspaper, radio and television stations, and police and let them know that you are a member of a national communications effort towards investigating UFO's. Ask that any reports be given immediately to you and offer to let them know, if they are interested, if something should appear to be headed your way from some other area.

. . . Wayne

Christmas Gift Ideas

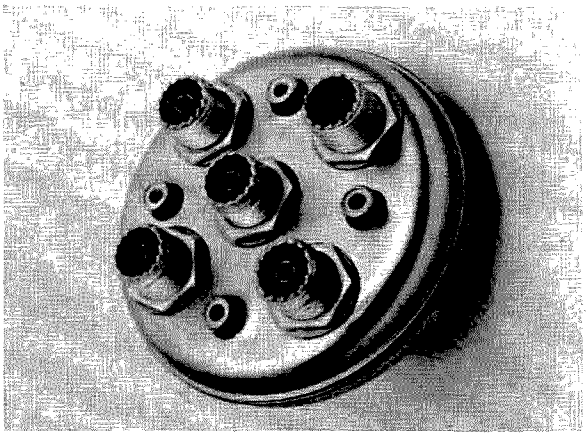
Are you trying to choose a gift for somebody with technical or amateur radio interests? That can be a very hard problem, if you do not understand what it is all about. Where can you turn for advice?

After reading through this list maybe you will feel a little more confident, and would like to try a catalog. Why not try our advertisers first? If you have a rather general kind of idea coming up maybe it's right in here on another page. Still another good approach is to talk with somebody having interests similar to the set you're trying to match. Finally, it helps to do some outside reading. Maybe you'll catch the bug and become a radio amateur too!

The items listed here are not specialized. Test instruments are good reliable gifts, since some overlapping of their functions is good practice and the fellow with an expensive piece of gear usually likes to have a simpler, cheaper one. And since the fellow who is just starting generally wants the less expensive variety, too, a purchase in this department is almost sure-fire. Some caution, and good advice in choosing your purchase is indicated, though.

73 Magazine

At a risk of sounding slightly prejudiced we have to admit 73 *Magazine* is an excellent publication for anybody seriously interested in modern ham radio and technology. This year's issues have carried a wide variety of material ranging from simple construction articles to news about recent events in technology, from using old transistor radios to the latest on those remarkable radio signals from space. No other ham magazine offers this wide range of material, interesting to the career oriented man as well as to the hobbyist. A subscription will set you back $6.00 per year or $12.00 per three years, and might be supplemented with a book or two from 73 Press. Try our "73 Useful Transistor Circuits" or "Diode Circuits Handbook," two of the best idea books on the market and available at a dollar each.



New Coax Switch

You can disconnect your antenna and still use it, with this new 4-position tapped coaxial switch. In addition to the usual UHF fittings it has four RCA jacks permanently connected to the output lines. Circuits or antennas may be monitored even when they are not connected into the operating system.

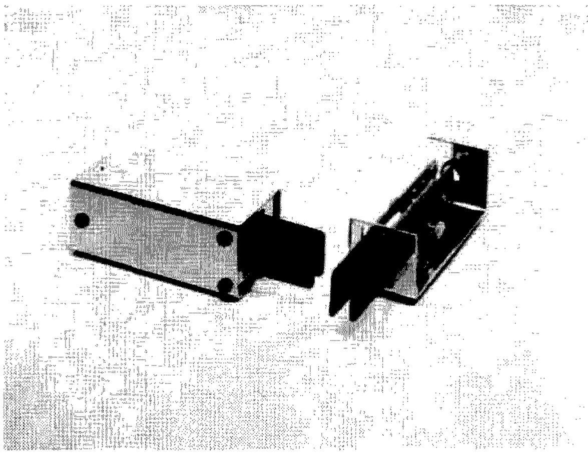
Some suggested applications are the connection of a general coverage of WWV receiver to the antenna system, installation of measuring devices or fix-tuned monitor receivers, or operation of a low-power rig through one of the disconnected antennas while the high-power rig is feeding another antenna.

Priced at about $12. For further information contact John W. Richardt, Jr., Electronic Applications Co., Route 46, Pine Brook, N.J. 07058.

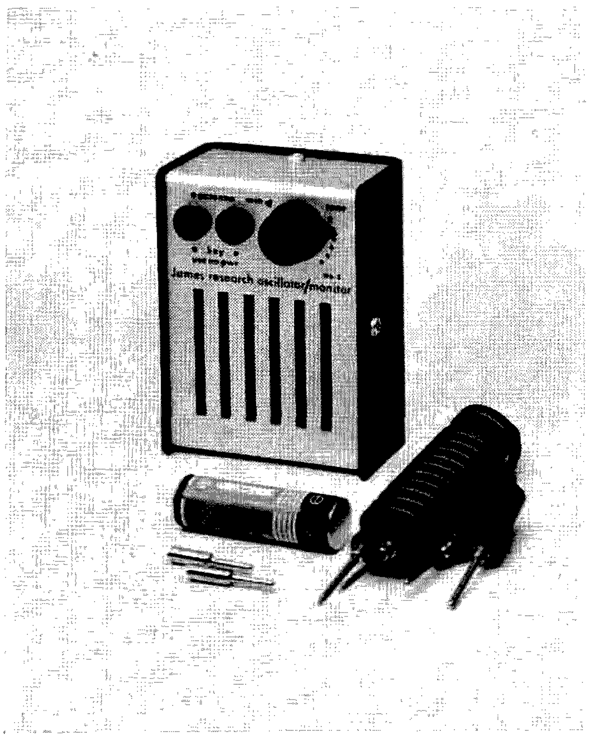
James Research Presents

Permaflex Key — $19.95
Oscillator/Monitor — $14.95

Many of the items offered in the Christmas Present line tend to be quite gadgety. Here are a couple of items that could be confused with members of this class, if you have to go by eye alone, but which really belong in the active & useful category. Both appear simple, yet both are unusual in some way, and will do effective jobs around the ham shack.



First, there is the Permaflex Key. It looks simple, and it is, in a way which hides the ingenuity and careful thinking that has gone into making this a really versatile and reliable key. We can expect imitations to appear in a few months; get the original.



The other item is a simple monitoring device, offering remarkable sensitivity. It serves to tell the operator when his CW transmitter is radiating *rf*, rather than when the transmitter is expected to be working. There is a large difference, sometimes. It requires no connection to the transmitter, a point with appreciable safety factor. It can also be used for workbench applications in new gear construction, and finally it will serve as a code practice oscillator.

The Mark 2 Oscillator/monitor incorporates all of the features of the original unit which has gained acceptance by amateurs as a sensitive *rf* type of CW monitor and a code practice oscillator.

Extended amateur as well as professional use of the unit as a Test Instrument has prompted improvement in its performance and utility.

The Mark 2 features:

Increased *rf* sensitivity by the use of cryogenic production control techniques. The Mark 2 will trigger on less than 10 Milliwatts without direct connection.

Greater audio volume and wider tone control range through the use of improved components.

Improved reliability by the use of stainless steel battery contacts which are impervious to corrosion.

A more rugged finish by the use of hard anodic coating on the aluminum cabinet.

Improved ease of use by supplying test leads, tip jacks, battery, and convenience magnetic base with each unit.

Longer assurance of trouble-free performance as backed up by our extended guarantee of 1 full year.

Price $14.95.

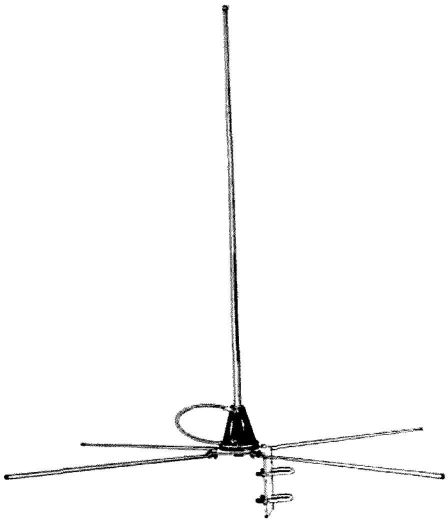
Address all correspondence to: THE JAMES RESEARCH COMPANY, DEP'T AR–M 11 Schermenhorn Street, Brooklyn, New York 11201.

Printed Circuit Kit

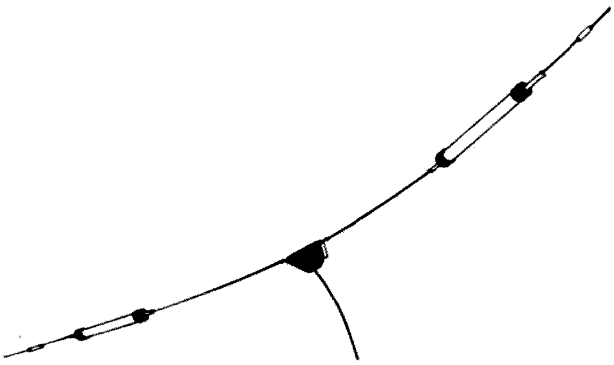
Injectorall Electronics Corp. has just released a much-needed printed circuit circuit kit. It contains etchant, resist ink, resist solvent, and other material required

to make up two small printed circuit boards. And then the pen and ink will do for very many additional boards, using surplus or other available board materials. Retails at $5.95, from local distributors. For further information write to Injectorall Electronics Corp., Great Neck, N.Y. 11024.

New Mosley Antennas



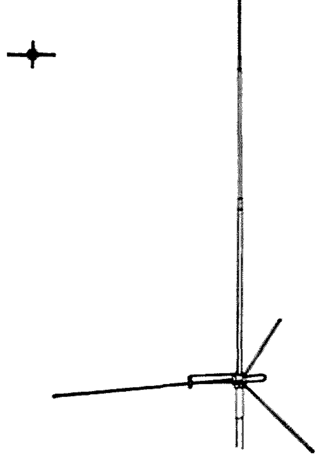
Here is a simple 2-meter antenna, engineering and construction all done, which comes at a very competitive price. The price is even competitive with building your own, if you consider the time that takes and the cost of materials. VSWR better than 1.5:1 over the range of 144 to 148 MHz. $10.58, ask for the Model D1-2 manufactured by Mosley Electronics, Inc., 4610 N. Lindberg Blvd., Bridgeton, Missouri.



Which are the three best ham bands? If you'd like to try for 10, 15 and 20 meters, or for 10, 15 and 40 meters, here is a trap antenna that will operate as a half-wave on three bands without any switching operations. A strain-relief connector takes 52 or 72 ohm coax cable, and end insulators are provided with the antenna. Rated at 1000 watts PEP for sideband communications. Priced at $17.59 from Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

MOSLEY DIPLOMAT 6

ANTENNA MODEL DI-6



Rated at 2000 watts PEP or 1000 watts CW, the Mosley D1-6 six-meter antenna offers an omnidirectional pattern for general communications use. It is vertically polarized. A special adjustable coupling arrangement provides for optimizing operation at either end of the six-meter band, and swaged aluminum rods serve to reduce wind loading and metal fatigue. The antenna mounts on 1" to 1¼" pipe. Priced at $19.76. Write to Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo., or ask your local ham or electronics dealer.

Here is a complete dipole antenna system priced well under our rather stretchy $25 limit. A dipole antenna is about the simplest kind of antenna that is really effective without getting into special circuits. Very appropriate for the young short-wave listener, the antenna can also be used for transmitting up to maximum legal power on all amateur bands through 10 meters.

The set comes with detailed assembly instructions for installing the antenna as a horizontal dipole or inverted V configuration. A center connector provides for connection to a coax cable, and end insulators are included. The DIV-80 kit is available from Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042. Shipping weight 3 pounds, and it is indeed under $25—it's priced at $7.42. A Best Buy.

Antenna Switch

Not all ham radio work goes on indoors, as you probably know already. Maybe there are several outside antennas, fed by one transmission line (which may be a powerful economy arrangement) or perhaps there are adjustments that must be made at the base or the center of the antenna. The least expensive approach involves many trips out to the antenna, or up the mast, but here is a remote-control switch arrangement that may do the same job. It will work with balanced or unbalanced lines (and that's all there are!) for switching or tuning applications. Ask for their Tenna Switch from the Cubex Co., PO Box 732, Altadena, Calif. 91001, at $17.95 postpaid. Also available from some dealers.

IC Projects Handbook

If you'd like to pick up two or three IC's and try getting your feet wet in the field, a copy of Brown & Kneitel's book may be just the thing for you. There isn't much chance of going in over your head, and some of the projects are unbelievably simple. To an eye accustomed to the complex schematics of discrete-components circuits IC circuits just don t look real. Yet the trend in electronics is to these tiny functional packages, and they do deserve a lot of attention. With this handy collection, you can get in some good bench work without spending days catching up on the literature.

The fifty circuits include power supplies (which I'd have placed to the front of the

book), a variety of preamps, amplifiers to 50 watts, three code keyers, some signal boosters and other circuits. There are several lab circuits, and I specially noticed a TV color-bar generator that is about as complex as a basic AM receiver—because it uses's IC's.

I thought the book seemed a little odd, without any schematics of the circuits inside the IC's. But then I came to page 127 and found Brown provided a complete set of IC schematics in a separate section. Sometimes these are needed to answer hard questions about circuit behavior. It would have been nicer if parts values could have been included since manufacturers do supply this information. And a couple pages of acknowledgements and a bibliography of other places to look for more details would have been nice, too.

This looks like a nice book to have around, if you're interested in modern electronics. *Electronic Hobbyist's IC Project Handbook* TAB book # 464 by Bob Brown and Tom Kneitel $6.95 hardbound, $3.95 Paperback

Second Op.

Recently revised and brought up to date, the Second Op operating aid quickly provides DX data on stations all over the world. Which zone is he in? Which continent? Country? How about postage, IRC data, QSL bureas? It is all there and the complete collection, ready to use, sets you back a buck and a half postpaid. Current fifth edition, from Publications in Electronics, Inc., 610 Tower Bldg., 216 West Washington Ave., South Bend, Indiana 46601.

Page 1

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

1. DATE OF FILING: October 18, 1968
2. TITLE OF PUBLICATION: 73 Magazine
3. FREQUENCY OF ISSUE: Monthly
4. LOCATION OF KNOWN OFFICE OF PUBLICATION: Peterborough NH 03458
5. LOCATION OF THE HEADQUARTERS OR GENERAL BUSINESS OFFICES OF THE PUBLISHERS: Peterborough NH 03458
6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR
   - PUBLISHER: Wayne Green, Peterborough NH 03458
   - EDITOR: Kayla Bloom, Dublin NH
   - MANAGING EDITOR:
7. OWNER

NAME	ADDRESS
73 Inc.	Peterborough NH 03458
Stockholder: Wayne Green	Peterborough NH 03458

8. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES OR OTHER SECURITIES

9. FOR COMPLETION BY NONPROFIT ORGANIZATIONS AUTHORIZED TO MAIL AT SPECIAL RATES

10. EXTENT AND NATURE OF CIRCULATION	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MONTHS	ACTUAL NUMBER OF COPIES OF SINGLE ISSUE PUBLISHED NEAREST TO FILING DATE
A. TOTAL NO. COPIES PRINTED (Net Press Run)	60,275	65,189
B. PAID CIRCULATION 1. SALES THROUGH DEALERS AND CARRIERS, STREET VENDORS AND COUNTER SALES		
2. MAIL SUBSCRIPTIONS	59,680	64,591
C. TOTAL PAID CIRCULATION	59,680	64,591
D. FREE DISTRIBUTION (including samples) BY MAIL, CARRIER OR OTHER MEANS	135	120
E. TOTAL DISTRIBUTION (Sum of C and D)	59,715	64,711
F. OFFICE USE, LEFT-OVER, UNACCOUNTED, SPOILED AFTER PRINTING	560	478
G. TOTAL (Sum of E & F—should equal net press run shown in A)	60,275	65,189

I certify that the statements made by me above are correct and complete.

Wayne Green

POD Form 3526

RCA Hobby Circuits Manual

This new 224 page manual contains detailed instructions on the construction of 35 practical solid-state circuits for use in the home, automobile, photo lab, and ham shack. It also contains easy to read sections on the theory and practical application of solid-state devices, including ICs and MOS FETs. It should be a useful and interesting book to anyone interested in the dynamic field of semiconductor circuits.

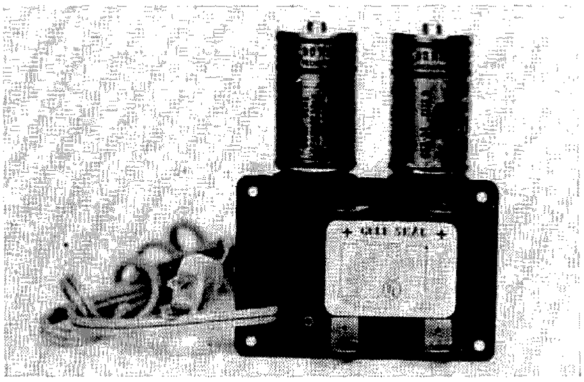
The dip-wave meter being examined by Jack Sterner W2GQK is only one of a dozen solid state circuits of interest to the amateur, covered in the Solid State Hobby Circuits Manual (HM-90) which is available from RCA for $1.75. Additional information is available from your RCA Distributor or from Commercial Engineering, RCA/Electronic Components, Harrison, N.J. 07029.

Radio Shack

A very important part of learning electronics is the discovery of the basic relation between real physical circuits and the schematic diagrams that represent the circuits to the engineer and the designer. This relation is clearest to the beginner who uses it most, and Radio Shack's 10-8 in-one Electronic Project Kit is a good beginner oriented instruction device.

Without soldering or exposure to high voltages, the beginner can quickly wire up several assorted, quite different circuits. They can be torn down and reassembled again, in the manner of a Tinkertoy set. Are those still on the market? If you're old enough to be raising a family you may remember those. Well, this is a sort of an electronic Tinkertoy set, and has excellent educational and practical value.

Ask for Radio Shack's #28-202 Electronic Project Kit, at $7.95.



Battery Recharger

If you have an application that uses lots of batteries, why not think about a rechargeable cell installation? For instance, Gold Seal Battery Co. announces one of their new low cost rechargeable cells will replace a series of 100-zinc-carbon cells, at a cost of $1.10. The rechargeable cells are sealed. A charger drawing 3.3 watts is also available, with a capacity of one or two cells for recharging.

Rechargeable batteries are available from stock at $.10 per D cell, and the Model 201 charger is priced at $4.75. Mail orders add 50¢ please, or you can try a local dealer. From Gold Seal Battery Co., 7350 Reseda Boulevard, PO Box 927, Reseda, Calif. 91335.

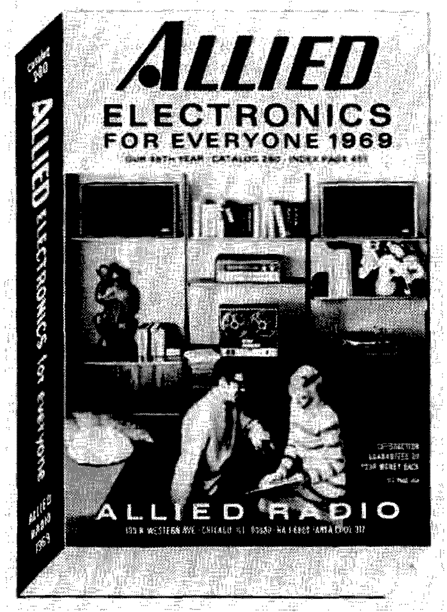
From Spark To Space

The story of ham radio in Canada is presented in a very interesting and readable booklet put out by the Saskatoon Amateur Radio Club. I very much enjoyed reading it. The editors (I think it was written by a group) used a historical approach, covering their subject from the beginning right

up to some space communications work hams are doing now. I especially liked the many excellent photos of old radio gear and workers, and on page 87 I noticed the Lakeshore Darts, Draughts, Chowder and Marching Society.

Seems some Canadian hams had a problem of commuting to Montreal to make regular meetings. After discussions on 75 Meters they tried a meeting at a local tavern. About 50 hams attented the meeting and shortly decided on a highly informal approach. Wonderful idea, isn't it? Somehow they ended up with a club title that is often abbreviated to "The Darts & Draughts Club."

Its thoroughgoing historical approach recommends this book. Grade: A.
$2.50 from P. O. Box 751, Saskatoon, Sask., Canada



Allied Radio

If you are interested in some good basic hardware and utility test gear, try Allied. Incidentally, they sell some very expensive and good materials, too.

Allied's KG-646 VOM kit #22C3907 goes for $11.95 (one pound), is a general-purpose basic meter, very appropriate for many bench testing applications. It is good around a car, too. A more elaborate instrument, well worth the higher price, is Allied's KG-620 VTVM kit. 22C 3911 W The VTVM does the same job as the KG-646 multimeter but uses a vacuum tube to improve its sensitivity. It can be used for applications

where the less sensitive multimeter will not work, and there are typically so many of these that a technical worker will purchase the VTVM first.

Two other items from Allied's large catalog deserve special attention. One is their top-quality Ersin solder, available in 1 pound rolls at $3.40 (1¾ lb. shipping wt.) Order #26C1733. This is very good stuff and a pound will last for some time. And the other suggestion is several Vlchek plastic parts boxes, #26C2094 at $1.95. (1 lb. shipping wt. each). These are the best product available for dealing with the parts situation.

Remember to ask for their catalog #280, too. All from Allied Radio, 100 N. Western Ave., Chicago, Ill. 60680.

Lafayette Radio Co.

Maybe this is a bit out of the ham radio field, or maybe not. A really good loudspeaker can do wonders for a radio receiver, since incoming signals are distorted less during their transition from electrial to sound waves. Lafayette has been selling their SK-58A speakers for several years, and these remain popular because they offer a lot for the price. Try their number 99H0014W 12" hi-fi speaker (11 pounds) at $24.95.

Or if you want to achieve the same effect on a smaller scale you could try a pair of Lafayette's F-767 hi-fi stereo headphones. Consumer Reports gave these an excellent rating a few years back and they have been selling like mad ever since. Two significant advantages are, they will do a fine job on a couple of milliwatts of power, and they are not audible all over the house. Tone quality is excellent. Lafayette #99H0035, (2½ pounds) a Best Buy at $11.88.

ARRL Books

The ARRL sells a large variety of simplified technical literature. Some people think this material does not reflect the progress of modern communications and electronics, but there is a gradual year-to-year improvement. And the publications are found everywhere.

At $3.00, the Radio Amateur's Handbook is one of the most generally used construction and shop practices handbooks available, and you can probably find it locally at a radio store. Try your library if you want to see a copy, and almost anybody who is an amateur operator will have one.

Carl C. Drumeller W5EHC
5824 *N.W.* 58*th St.*
Warr Acres, Oklahoma 73122

Three Black Boxes

Fig. 1. Three black boxes which make up a station.

The basic concept of a radio transmitting station often gets overlooked in concern with details. It is good to back off and take a look at just what makes up a radio transmitting station. With this thoroughly understood, we can make a more fruitful approach to the design and application of those components that make up a station.

If we erase the black and look into the left-most box, we could see any one of an almost infinite variety of radio-frequency generators plus its primary power supply. Stripped down to basic symbolic representation, it looks like what's shown in Fig. 2. This is true regardless of whether the transmitter uses vacuum tubes, transistors, *rf* alternator, or any other simple or exotic device for generating *rf* energy. It's also true whether the device is for radiotelegraphy or for radiotelephony; whether it is amplitude modulated, frequency modulated, pulse modulated, or any other variant you can dream up.

For the next step, let's skip the middle box and consider the right-hand one. It denotes the radiating device, normally an antenna. An antenna, like a generator, can have an infinite variety of forms: Capacitor, loop, ferrite, magnetic, electrostatic, vertical polarization, horizontal polarization, a c t i v e, passive, frequency-discriminating, broad-band, etc., etc.

To this, add another infinite series of possible feed systems and you'll see why it's wise to show just a black box! Regardless of its physical nature or its electrical configuration, the antenna (and its feedline, if one's involved) has but one function: To couple the *rf* power output of the transmitter to the 377-ohm intrinsic impedance of space in such a manner as to obtain the required radiation pattern (directional, non-directional, vertically-polarized, etc.) At the space-antenna interface, the impedance is 377 ohms. What that impedance is at the spot where the antenna-feeder system inter-connects with the middle black box is a matter that varies greatly, both in the magnitude of impedance and in the nature of impedance (resistive, capacitive plus resistive, inductive plus resistive). This is why the middle box is so important to the functioning of the total radio transmitting station.

Two basic functions are performed by the middle black box. One is frequency discrimination (or selection). The other is impedance matching. Very few generators of radio-frequency alternating current produce pure sinusoidal waveforms. Almost always there is an appreciable harmonic content which must be rejected. In certain types of transmitters, there are undesired by-products of frequency conversions that must not be allowed to radiate. Therefore the middle box has a "tuning" function.

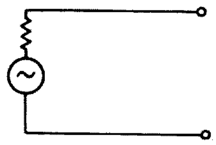


Fig. 2. Basic symbolic representation of any rf generator.

The second function, impedance matching, is more complex. Because of this complexity, it is more difficult to achieve during design and construction. By the same token, it's less well understood. Too many publications gloss over the subject with a few time-worn platitudes that serve only to entrench midunderstanding. The discussions you hear over the air and at amateur radio gatherings reveal the lack of understanding. Yet the basic subject, like most

basic subjects, is quite simple and should not be difficult to understand thoroughly. This, of course, holds true only if you don't confuse the situation by making it unnecessarily complex.

Go back to **Fig. 2** and take another look at it. You'll see a generator with its internal resistance. To take maximum power out of this generator, you need to have a load equal to that internal resistance. (Sometimes, for reasons we'll not treat here, we want to mismatch the load. This will decrease the transfer of power but may achieve another, and desired, purpose.) Note that I wrote "resistance", not "impedance". In almost all instances, we'll need a pure resistance to load the generator. Supplying this pure resistance, in the desired magnitude, is the second job we ask the middle black box to do.

You'll recall that the right-hand black box, the antenna plus its feed system, had a very wide range of possible impedances. The middle black box must process these impedances and convert them to a stipulated value of pure resistance. Note that I used the plural form, not singular. Very seldom will this impedance remain constant in an amateur radio station, with its ability to cover many frequencies within a band and many bands within the Amateur Service allocations.

Let's say we have a transmitter with a vacuum tube requiring a load (resistive of 4000 ohms. Also, that we have a doublet antenna center-fed with 52-ohm coaxial cable. There is a small probability that at one frequency (hopefully within an amateur band) this will present an impedance of $52 + j\emptyset$ to the middle black box. Transforming this to $4000 + j\emptyset$ with a pi-network presents no real problem to either a designer or a constructor. Even $25 + j\emptyset$ or $100 + j\emptyset$ can be copied readily. These idyllic situations seldom are found in amateur radio stations other than those using rhombic, disc-cone, or log-periodic antennas! So let's go back to that doublet. As soon as you depart from the one frequency where you found the "ideal" impedance, you'll notice j $\emptyset$ vanishing. In its place will be a finite value of either plus or minus j (depending upon the direction of frequency departure) which will increase in magnitude quite rapidly as you swing away from the "ideal" frequency. These values of reactance ("j") are not so simply dealt with by the usual pi-network. They can be coped with, within reason, but to do so requires the design (and construction) of a very flexible impedance-matching circuit. If the middle black box is to perform its full function, this flexibility must be present. Because this device helps to achieve an impedance match, it should be thought of as an integral part of the middle black box.

So you see, a radio transmitting station may be shown as three black boxes. One holds the generator, one holds the impedance-matching portion, one holds the radiating section. One generates the rf power, one matches the generator to the radiator, one matches the radiator to space. Quite simple!

. . . W5EHC

Ralph Steinberg K6GKX,
110 Argonne Ave.
Long Beach, Calif. 90803

Facsimile and the Radio Amateur

It's fun and exciting to experiment with facsimile. This mode of communication is gradually becoming as popular as slow-scan television and teletype. There are many potentials for which facsimile can be used in amateur radio. Before we discuss these potentials there are some facts and experiences your author had with facsimile which may be interesting.

From April to the middle of September, Propect Facsimile Antarctic logged more than 300 hours transmitting pictures to KC4USV at McMurdo Station. Although the distance was 8000 miles from the transmitting station to the receiving station, eighty-five percent of the pictures received were of good quality and contrast on their initial transmissions. The small percentage which were of poor or fair quality were retransmitted and received in normal quality. Successful transmissions were made with signal reports of S3 although for the majority, reports were S7 to S9. Some evenings only one picture got through to McMurdo Station before the band "folded", while on other evenings as many as two to ten pictures were transmitted with very good copy. Very little interference was noticed during the six months period of facsimile operations and this may have been due to the selection of frequencies (14.100 to 14.200 MHz) authorized by the Federal Communications Commission. The biggest problem of the facsimile operations were the magnetic storms in the Antarctic which delayed transmitting schedules from one day to a week at a time.

For those not acquainted with facsimile equipment or the operations, this introduction may be of interest and possibly the beginning of another mode of communications for experimentation.

Facsimile Photo of Miss California as received at McMurdo.

Introduction

Facsimile transmission consists of sending pictures or other printed material by radio or land line. It makes use of the process known as scanning. The scanning like the human eye follows each horizontal line from left to right and returns to a starting point at the left hand side of the page or picture and repeats the process many times to reach the bottom. This produces a permanent copy of any material whether type, script, photographs or schematics. Facsimile equipment as used today requires a slow speed (usually 60 rpm for amateur radio) which produces a copy of the record in a matter of minutes.

In the transmitting of facsimile a picture is scanned about 100 lines per inch. As the light beam passes over each portion of the picture it is reflected into a photoelectric cell and the variation in the intensity of the reflected light, due to the character of the picture, creates voltage variations in the output circuit of the photo-cell. These variations make up the picture signal and are a source of modulation for the radio frequency carrier of a transmitter. At the receiving station, the signal is demodulated and the voltage variations created at the transmitter are used to operate a recorder.

The potentials of facsimile communications in amateur radio are unlimited. It needs only imagination to find ways to use facsimile for many purposes. Some common applications in amateur radio are sending and receiving pictures, schematics, bulletins or QSL cards plus anything that calls for a permanent record. There are radio amateurs who have facsimile equipment and use it for copying weather maps from Canada and the satellites high above the earth. In tornado and hurricane areas, these weather maps would help the NCS of the warning networks. The NCS with facsimile equipment would have advanced information on the weather and a permanent record of the weather map.

Equipment

The equipment used by Project Facsimile Antarctic during the facsimile operations to the Antarctic was the TXC-1B Times Corporation Transceiver, MD 168 Modulator, RD 92A/UX Receiving Recorder and CV 1066A Receiving Converter. This was all compatible with the fascsimile equipment at McMurdo Station in the Antarctic. Although the TXC-1B Transceiver can be used for transmitting and receiving, the RD 92A/UX was used as a monitor for all transmissions and occasionally for receiving.

The TXC-1B Transceiver is an electro-mechanical-optical facsimile set of the revolving drum type for the transmission and receiving of pictures, printed matter, maps or sketches. Received copy is recorded on chemically treated paper. The equipment will transmit or receive a page of copy 12 x 18 inches in 20 minutes. The MD 168 Modulator is used to convert amplitude modulated facsimile signals from the TXC-1B Transceiver to audio frequency shift facsimile signals of 1500 to 2300 cycles. The input signal to the modulator has a frequency of 1800 cycles and an amplitude that varies with the light and the dark parts of the picture being scanned at the facsimile transmitted. The output signal from the modulator is an audio signal with 1500 cycles the maximum signal input and 2300 cycles the minimum signal input to the modulator from the facsimile transmitter. As the audio frequency-shift signal from the modulator is of constant amplitude the transmitted radio frequency from the radio transmitter is modulated at a constant percentage of modulation and is known as subcarrier - frequency modulation.

To receive the audio frequency-shifted signal, the RD 92A/UX Recorder was connected with a CV 1066A/UX Converter. This converted the audio frequency-shifted signal output of the radio receiver into an amplitude modulated signal suitable for the facsimile recorder.

Although Times Corporation Facsimile equipment was used for the operations of Project Fecsimile Antarctic, there are other manufacturers of this equipment such as J. P. Seeburg Corp. who build their machines for Western Union Telegraph Company and the Alden Electronic & Impulse Recording Equipment Company for the U.S. Weather Bureau Stations. Both companies have adjustable speeds on their recorders and can be made compatible between receiving and transmitting stations.

Radio amateurs interested in experimenting with facsimile equipment can secure it through the MARS program, when available. Recently Western Union Telegraph Company donated some of their older model "Interfax" equipment to the radio amateurs in some of the larger cities. If you live in or near one of the larger cities of the United States, contact the technical service manager of the telegraph company. Mention you are a radio amateur and that you wish to experiment with facsimile and would appreciate one of their discontinued models of facsimile equipment, *interfax*. You might be lucky. On the Alden Facsimile equipment, this company sells their discontinued models and inquiries should be addressed to their main office in Westboro, Mass.

Facsimile operations at present are assigned to the frequencies from 50 MHz to 40,000 MHz, however special permission must be authorized by the Federal Communications Commission to use it on the low bands. With slow-scan television just recently becoming legal on the low bands, it is hoped that facsimile operations will also be legally allowed on these bands.

There was lots of work attached to Project Facsimile Antarctic, but Earl, WA6URW, Ellis, WB6EGH and I enjoyed every minute of it. Try experimenting with facsimile and you will feel the same way. . . . K6GKK

Why SSB?

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Required Reading for the Die-Hard AM Operator

Would you believe that, in this electronic age, there are still amateur radio stations without the capability of SSB operation? If you find this fact plausible, it should not be difficult to convince you that there are also many hams who don't really know what single sideband is all about (and some of these hams are operating SSB exclusively). We are all familiar with the clichés of the SSB versus AM controversy: "Twice the output of AM with the same power"; "I would need a special receiver"; I don't want anything to do with that quack sounding stuff"; "It only uses half the spectrum space of AM". But how many of us have actually taken the time and trouble to do a little reading to see just what the advantages are to utilizing single sideband as a mode of transmission, and what we must obtain in the way of basic equipment, or put out in cash, to either change to or add SSB to the present station?

Fig. 1 is provided as an overall comparison of AM, double sideband, and single sideband in easy-to-read table format with the hope that it will create enough interest among the non-believers to convince them to read the article. The gain figures are computed with a reference of 1 and are given only as average power values which do not show actual gain advantage. If you have already designed and constructed a single sideband transmitter, this article probably won't tell you anything new. If you have just added a product detector to that old station receiver to make it easier to receive SSB signals, but haven't gotten around to obtaining a transmitter, this article should convince you to take the final step. In the event any of the die-hard AM operators have been stimulated to read this far, be advised that this article is mainly meant for you. Even if you don't believe everything you read it might give you some extra ammunition for your altercations with the "Quackers". In the following paragraphs I have tried to state the differences (not necessary advantages) between AM and SSB in easy to understand terms and give examples which should emphasize the points in various ways. Although double sideband is not a common mode of transmission for hams, its characteristics are included for comparison purposes.

Power

Unfortunately, the most important consideration of the present-day ham appears to be the amount of power the transmitter can provide. With a well matched antenna system we expect all the power in the transmitter final to be transferred to the antenna and into the ether. This case naturally considers the transmission line to be lossless and the antenna to be a perfect radiater. This generalized impression is misleading. First, considering AM transmitters, we must remember that the power is usually given by the manufacturer as so many watts input. This value is dc watts input to the final and, since we cannot expect the final tube to be much over 75% efficient, the unmodulated output will be much less than the rated input. When the transmitter is modulated 100% with a pure sine wave the dc power is varied at the frequency of the sine wave and increased 50% in amplitude. That sounds fine, you say, because allowing for some peak power loss we still have as much average output when modulating with voice as the stated dc power input. However, the power leaving the final of the AM transmitter, and thus that power being sent along the airwaves toward that rare DX station, is not all contributing to the best possible reception on the other end. The transmitter had a carrier frequency which was modulated in order to transmit some intelligence, in this case your voice. Therefore, a band of frequencies

1000 W Av. Output Eff. = 100%	Power Distribution Carrier	USB	LSB	System Gain	Power Gain	Spectrum Space	S/N Advan.
AM	666.6 W	166.7 W	166.7 W	25 db	22 db	6 kHz	None
DSB	Insig.	500 W	500 W	27 db	27 db	6 kHz	None
SSB	Insig.	1000 W in either sideband		30 db	30 db	3 kHz	None

Fig. 1. *Overall comparison of the three modes.*

determined by your voice and the circuit elements of the modulator was mixed with the carrier frequency, producing the carrier, upper sideband, and lower sideband, both of which contain the same information. However, as you remember, we said above that the power could be increased a maximum of 50% by 100% modulation. This increase in power is equally divided between the two sidebands while the major part of the transmitted power is taken by the carrier. Since the carrier contains no intelligence, and only one sideband is necessary at the receiving site for demodulation, our effective power is only one sixth of that being transmitted. In other words, the transmitted AM signal has two thirds of its power in the carrier and only one third in the sidebands.

If we were to suppress the carrier and feed only the two sidebands to the final stage all power would be transmitted in the sidebands, thus doubling our effective power.

Progressing further along this line of thought, if we suppress the carrier and feed the final stage with only one sideband, it should be possible to use the available power to transmit the single sideband, thus utlizing all the power for the transmission of intelligence. This is indeed the case and we have again doubled our effective power.

Example 1: For a transmitter rated at 5KW output and modulated 100%, the power will be divided:

	LSB	Carrier	USB
AM	833.3W	3333.2W	833.3W
DSB	2.5 KW	Insig.	2.5 KW
SSB	5 KW in either sideband		

Example 2: Looking at it another way, the AM transmitter in the above example must have a total output of 30KW to equal the power of the 5 KW SSB transmitter. Therefore, the system gain of the SSB transmitter is six times that of the AM transmitter and the gain in db is:

$$10 \log 6 = 7.78 \text{ db}$$

The above examples were made on the basis of equal signal-to-noise ratios at the receiver, which as explained later is valid, and no limitation to the peak power of the AM final amplifier. However, since the amateur service is allowed to feed the final transmitter stage with only 1000 W, this value obviously becomes the limiting factor.

In an AM transmission the peak amplitude (at maximum voltage swing) for a 100% modulated wave is twice the amplitude of the carrier wave alone. Therefore, the peak power of the modulated wave is four times the normal carrier power. This is caused by the doubling of the plate voltage of the amplifier at the peaks of the modulating wave. When the voltage (E) is doubled, the power will increase four times according to the formula:

$$P = \frac{E^2}{R}$$

Where P = Power out
E = B+ Voltage
R = B+ Resistor

In other words, the power in a 100% modulated wave is 50% greater than the carrier wave alone. Then, if we have a 1 KW carrier signal and a 100% modulated feeding the final stage, our modulated output would be 1.5 KW, disregarding tube efficiency. The peak power output would be four times the normal carrier power or 4 KW.

Example 3: Using the limiting factor of 1000 W unmodulated input to the final we can see that only 500 W can be provided for both sidebands or 250 W in each. This means the AM system can provide an average power (both sidebands) of 500 W to 1000 W for the SSB system, or a 2:1 advantage for the SSB system.

Example 4: Utilizing peak power as a reference, the AM system must peak at 4 KW to equal the SSB peak power of 1 KW. However, the AM system can produce only 500 W in both sidebands while the SSB system can put the whole gallon in one sideband. This ratio of 4 KW:0.5 KW or 8:1 gives the SSB system a signal power advantage of:

$$10 \log 8 = 9 \text{ db}$$

This is just about the difference between a dipole and a junior sized 3 element beam!

Spectrum Requirements

A well designed communications system is not intended to efficiently transmit high fidelity music. If we desired to transmit such material with a frequency range of 20 Hz to 20 kHz using normal amplitude modulation, 40 kHz of spectrum space would be necessary. Some time ago telephone company engineers found that satisfactory voice communications could be transmitted using only the 300 Hz to 3 kHz portion of the audio range. Therefore, audio amplifiers, modulators, and filters are designed to pass only this range of frequencies. Although seemingly narrow when compared to the high fidelity limits, this band of audio frequencies provides intelligible communications. If you have ever noticed the problem of tuning in a YL operator on SSB, you will realize that the higher range of voice frequencies appears to make the bandwidth narrower than it really is.

Example 5: Utilizing only these audio frequencies, the normal AM transmitter will produce sidebands a minimum of 3 kHz above and below the carrier frequency, thus using a total spectrum space of 6 kHz.

Example 6: A single sideband transmitter using the same audio frequencies will produce only one sideband either 3 kHz above or below the carrier frequency, depending on which sideband is being transmitted. As shown, a single sideband transmitter requires only one half the spectrum space necessary for AM transmission.

In addition to the above saving in spectrum space, there is another benefit of SSB which is often forgotten. By greatly suppressing the carrier, we have removed a major source of interference from the bands. When two AM stations are utilizing frequencies less than 6 kHz from each other, interference is caused by heterodyning of the carriers. Two SSB stations, both operating on the same sideband, can easily transmit within 3 kHz of each other without causing interference. It is also possible to operate SSB at even narrower intervals due to the missing carrier, the only interference being in the form of "monkey chatter" caused by the audio of the nearby station.

Example 7: Considering the above facts, a 96 kHz portion of the frequency spectrum could be effectively utilized by 16 AM stations or 32 SSB stations. Intelligible communications could also be obtained if an additional 16 SSB stations were evenly spaced among the already present 32. This would give every one of the 48 SSB channels a bandwidth of 2 kHz. Thus an average ratio number of possible transmitters per mode to required spectrum space would show a 48:16 or 3:1 advantage for the SSB mode.

Noise and Propagation

In examples 1 and 2, we noted that the calculations were made on the basis of equal signal-to-noise ratios in the receiver for both AM and SSB signals. The AM receiver detector usually has a 6 kHz bandwidth signal to work with so that both sidebands are demodulated producing equal audio outputs. The SSB system has only one sideband to be demodulated, thus produces only one detector output at one half the amplitude of the AM radio.

Example 8: Although the AM receiver detector produces twice as much audio from an AM signal, the noise on both AM sidebands is twice that on the one SSB sideband, thus there is no signal-to-noise advantage for either system.

At first glance it would appear that we should see some improvement in AM long distance communication over SSB, as far as the signal-to-noise ratio is concerned, due to the wider bandwidth. The Hartley-Shannon law tells us that the total information in a signal is directly proportional to the bandwidth, time taken to send the information, and the signal-to-noise ratio. Therefore, a certain amount of noise interference on a long transmission path can be overcome by increasing the bandwidth of the signal. However, although the AM sidebands cooperate to raise the power output in an AM system, they tend to work against each other over the long distance path when fading occurs. This is due to the fact that the sidebands in an AM system are being "transmitted" by the carrier. When the carrier is received by two different ionospheric signal paths, the different lengths of the paths cause the received signals to be out of phase with each other. The amount of phase difference is dependent on the signal paths and can be 180°, in which case complete cancellation occurs. Any phase difference of the carrier other than 180° will cause some de-

gree of fading but, more important, it will cause the sidebands to interfere with each other producing distorted audio. Such fading can be avoided by diversity reception (two receivers and two separate antennas) or refined receiver design with special phasing circuitry.

Example 9: Since the transmitted SSB signal contains no carrier, selective fading is not a problem and, under the same conditions, a 12 to 16 db improvement over AM can be realized.

It is possible to use the scatter phenomenon for medium distance (1000-2000 miles) communications. This effect is more prevalent on the high bands and is utilized by the military and government for reliable "back-up" systems. The transmission path is scattered and therefore is dependent on transmitter power rather than propagation conditions.

Example 10: Since communications using the scatter phenomenon is dependent on transmitter power and more power is available in the SSB system as compared to an AM system, it is possible to make contacts with SSB when the bands are "dead" for AM.

Reception

Because an AM signal is transmitted with a carrier it is a simple matter for the operator to find the signal and for the receiver detector to demodulate it producing an audio output. However, in SSB, where no significant carrier is transmitted, there will be no indication at the receiver of any signal being transmitted except when the operator at the other end speaks into the mike. Without a carrier to beat with the receiver heterodyning oscillators the AM detector has no reference and produces only unintelligible distortion. In order to receive SSB the carrier must be reinserted at the receiver. The point of insertion may be almost anywhere before the detector but must be the frequency of the transmitted signal. The best way to convert an AM receiver for SSB reception is to add a product detector. Since this article is not meant to get into the necessary circuitry for single sideband, suffice it to say that the product detector is essentially a mixer/demodulator which is fed with the incoming SSB signal at the *if* frequency. Because there is only one sideband, the driving oscillator output must be quite a bit higher than the signal amplitude to provide a useful audio

output. The biggest problem in this system, which may be considered a disadvantage by homebreders, is the necessary stability required for the BFO, or oscillator feeding the product detector.

Example 11: If the reinserted oscillator frequency is different from the transmitter suppressed carrier frequency, the output from the synchronous detector (product detector) will show an equal difference in the audio from the original modulating frequency. The injection oscillator frequency may differ from the carrier frequency by ±20 Hz without affecting intelligibility. However, frequency deviations greater than 50 Hz will produce only distortion from the product detector.

Reception of SSB on a receiver with a bfo is possible by setting the bfo at the center of its range and adjusting the *rf* gain control for best reception. Since only one sideband is being received, the audio gain will have to be increased. Although changing the *rf* gain will affect the S meter reading, such adjustment is necessary so that the bfo signal amplitude will be as high as possible above the signal level.

Transmission and Basic Costs

There are a number of companies which manufacture SSB adapters which can be used with most AM transmitters. The best route to go, however, is to purchase a new transmitter or transceiver. If you are still using an old AM/CW rig remember the trade-in value is getting lower every day. The cost of a 500 W (1000 WPEP) single sideband transmitter, which can be used on AM and CW by inserting the carrier, is no more expensive than an AM rig of the same power. Although the transmitter front end components, such as filters, audio networks, and balanced modulators are more expensive to design, there is a savings in the final amplifier where dissapation ratings can be lower than those required for AM. If you don't want to lay out any more cash than necessary (who does?) you can use the old transmitter and receiver as trade-ins on a new transceiver.

Example 12: *Old*

Surplus SP-600	$300
65 W Ranger II	$150
Trade-In Value	$450
New	
400 WPEP Swan 350 w/Power Supply	$525
Trade-In	$450
Cash Outlay	$ 75

If you have a linear amplfier, it can be used on SSB as well as AM. If you have been using a Class B amplifier for AM, there are plenty of articles in the "Radio Amateur's Handbook" and past issues of "QST" and "73" which provide information on construction of a linear and which could be used to modify the Class B amplifier to Class AB.

Now that you have read about the differences and possible advantages of SSB, how about dropping a line to one of the equipment dealers advertising in "73" and asking for a trade in quote on your old rig toward a more efficient SSB system. They will even pay the shipping costs!

. . . K3PUR

References:

Stoner, "New Sideband Handbook"

Capitol Radio Engineering Institute, "Communications Engineering Technology"

ARRL, "The Radio Amateur's Handbook"

Goodman, "What is Single Sideband Telephony?", QST, January 1948

Norgaard, "What About Single Sideband?", QST, May 1948

WIEMV continued from pg. 3

rich. Don't you believe it. Ham radio is merely a sideline with most of our manufacturers, or they couldn't afford to stay in business. The best you can say is that they get a tax break on their *losses* from ham radio. Just hope they stay with it, or you may have to drag out the soldering iron and go back to to the easy building of AM equipment.

. . . Kayla WIEMV

MOVING?

Every day we get a handful of wrappers back from the post office with either a change of address on them or a note that the subscriber has moved and left no address. The magazines are thrown out and just the wrapper returned. Please don't expect us to send you another copy if you forget to let us know about your new address. And remember that in this day of the extra rapid computer it takes six weeks to make an address change instead of the few days it used to when we worked slowly and by hand.

Limitations on Antenna Reciprocity

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This is an attempt to answer the question "How come?" in the February, 1968 issue of 73. Most amateurs are acquainted with the theory (variously called the Rayleigh-Helmholtz theory or the Carson theory of reciprocity) that a good transmitting antenna is reciprocally a good receiving antenna. This works well enough for us to tune an antenna in the one mode with reasonable confidence that it will then perform adequately in the other. However, as with most scientific theories, there are a number of underlying assumptions about other conditions being limited, uniform, and unvarying, and if one or more of these assumptions is not met, performance will be different from what is theoretically predicted. As anyone who has studied antennas carefully will attest, the complications in this field are indeed wonderful, but let us briefly examine a few which are quite likely to affect the amateur's attempt to estimate antenna performance.

In the first place, arguing that an antenna will perform reciprocally in the receiving and transmitting modes assumes that the medium in which wave propagation takes place is homogeneous. This is pretty nearly true for antennas which are mounted high above the earth and operating at line of sight distances with their major axes properly oriented, such as with VHF antennas situated on high towers operating over flat terrain. This assumption is almost never met on the lower bands or under skip conditions. Most amateurs are acquainted with what is called "one-way skip". Conditions can exist whereby the medium in which the wave is propagated is much more favorable for transmission from point A to point B than it is from point B to point A. One of the situations in which this is most readily apparent is on the VHF bands when there is a discontinuity in the temperature of the air masses overhead, producing what is frequently called tropospheric bending. The lens or prism effect in the air masses does not always work precisely the same going both ways. However, the lens is merely a crude analogy when applied to a discontinuity of the air, as is the analogy of a mirror to describe the higher ionized strata which turn a radio wave back toward earth.

Another complication of reflected propagation is that radio waves which go into the ionosphere may become turned around or twisted before being sent back. The result is that a wave which is vertically polarized upon leaving the transmitter may return to some far distant receiving station in a horizontally polarized condition. This means, of course, that an antenna which favors horizontal polarization usually works much better in receiving such a DX signal, although it may not make much difference in transmitting. This may be one of the reasons why people complain about the ineffectiveness of vertical antennas for receiving, although they consistently perform well for low-angle radiation in transmitting. It is not merely that the antenna may not work exactly the same both ways, but the same antenna used for receiving may not face the same conditions that it itself produces in transmitting.

On 144 MHz in the early 1950's, some of us in Cincinnati established to our own satisfaction that, for receiving, capture area was almost as important as gain itself. One of my friends found that transmitting with a large collinear ("bedspring") instead of a Yagi did not produce an appreciably greater signal in the other man's receiver but its use would greatly enhance the signal received at his own end. The explanation seems to lie in the greater capture area of the large "flat" antenna compared to the small "pointed" one. Unfortunately, to simulate this on low frequencies would require an installation comparable to some of the big transmitting antennas at the Voice

of America, consequently few hams ever get a chance to investigate the effect of capture area on the low frequency bands.

Related to this problem of capture area is what we might term the angle of acceptance of an antenna. This becomes a factor in multiple element arrays which are not flat with respect to the incoming wave front, whether of the Yagi or Quad or other type. We said that the reciprocity theory could be expected to work only if the antennas were properly oriented. Very few amateurs, even on the VHF or UHF bands, have facilities for controlling the orientation of the antenna except in rotating it horizontally (northeast, southwest, etc.) We know that the signal is not coming in parallel to the earth, but we usually do not do anything about it. Now if we were able to tilt the antenna boom and also rotate the boom axially we could begin to adjust the antenna to the proper attitude with respect to the wave fronts coming in. Some very surprising things would result if we could do so, and anyone who has tried it will bear this out.

I suspect that it is this factor of vertical orientation which may go far to explain the question asked by W4YM, with reference to comparing his two-element and four-element Quads. Much of the signal coming into either antenna is not coming straight on into the cone which we imagine in front of the leading element. Much of the signal is coming in from various angles above this.

Now if the vertical pattern of the antenna were smooth and regular, the angle at which the signal came into it would of course affect the "S" meter reading to some extent, but would not be very critical. Certainly it should not be any more critical than the horizontal angle, which is what we usually consider in the case of a beam. However, the fact is that on many antennas the vertical pattern exhibits several lobes and partial nulls. These are not planned and they are not particularly useful, and for the most part they are completely ignored. However, if the antenna happens to have a null in the forward direction at say, thirty degrees from the vertical, then with signals coming in at this angle, rotating the antenna horizontally will have very slight or erratic effects as compared to the antenna's performance on low-angle DX signals. Anyone who has played around with rotary beams during times of extreme short

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skip can verify these facts and can probably appreciate this explanation. This does not in any way mean that under conditions of high-angle radiation and reception a beam antenna is worthless, but it does mean that we just can't point the receiving antenna at the transmitting station in *one axis alone* and expect optimum results.

By the way, one of the major advantages I see in the Quad over the Yagi is that it compresses the signal vertically as well as horizontally and for a given horizontal angle of radiation or acceptance compresses more energy, and with a smooth pattern, since it is compressing at about the same angle vertically. With many Yagis things are very much different. Some Yagis which show a fine smooth pattern horizontally have a miserable and erratic pattern vertically. The easiest way to test this is to build small tabletop antennas, using as a signal source something like an *rf* interferometer. You can learn a great many instructive things about antenna patterns in this way without a great deal of expense. A satisfactory setup is a pingpong table sitting in your carport or out in the back yard, assuming that the antenna half-wave is only about four or five inches. A severe limitation on this method, however, is that it is exceedingly difficult to learn anything about antenna feed line impedences on these small antennas. As with all other branches of antenna experimenting, you give up something for everything you get.

Further complications in trying to compare a given antenna for transmission and reception lie in matching the feed line to the load. We all know that, in transmitting, antennas should be matched, to reduce the SWR. Moreover, we have reasonably good methods of measuring this in most modern amateur shacks. Note that I only say reasonably good, because our methods are far from any laboratory standard, but they are about as close as any practical need requires. However, I have never been in a ham shack which could do an equally good job of determining the match to the receiver. If the line is behaving differently in the receiving mode from its performance in transmission, we should not expect closely reciprocal results.

When it comes to signal level measurement, most amateurs are unable to compare from one station to another with even a usable degree of accuracy. About all an

"S" meter is good for is a tuning indicator and a take-off point for limited conversation with the man at the other end. I have tried calibrating "S" meters carefully on some of the receivers that I have built, but in recent years have given up and left the things off the receiver entirely. It was simply too much trouble to try to get a scale honest and linear across a usable range and when I did, an accurate report merely insulted the guy at the other end, who had been used to inflated reports from other people using some of the commercial receivers. Let me just state briefly and succinctly that any definitive work testing the reciprocity of a receiving-transmitting antenna would require signal measurement capabilities which were both appropriate and comparable at both ends of the circuit. This is almost never approximated. The best I could ever do was to calibrate my own receiver accurately for one band, using as a reference a transmitter across town where we had a pretty good measurement of the input power, and then testing the antennas we wished to compare between these same two stations, holding other variables constant. This, bear in mind, was for one path only. I could not say anything definitive about these same antennas operating across the reverse path.

Even working between stations in close proximity you may have to select sites carefully to get a clear path. Reflections from objects near the earth do some mighty funny things to a signal and severely distort the "free space" antenna patterns. Reflections from objects far from the earth can also do funny things. I'm told that signals coming back from the moon have a reverse spin, which means that the best antenna for transmitting is precisely the opposite in this aspect from the best one for receiving. The well known spiral ray used on VHF bands attempts to accommodate waves which may be arriving horizontally, or vertically, or somewhat in between. However, it does not take into account the variability in the direction of spin. Even imagining an antenna patterned after the spiral ray but equipped with enough rotation to adjust the elements for spin, and the tilt, axial rotation, and azimuthal rotation of the boom makes one shudder. By this time, we would have so many control wires going up to the antenna that the signal would have a hard time deciding what was the feedline.

In short, reciprocity theory is a great thing if you respect it for what it is. It does not readily permit an amateur to compare two different kinds of antennas with respect to different modes of use without controlling any of the other variables, which include all of the ones we have listed and a few more. In the words of one of my engineer friends, "What you have here is a complex system, and complex systems are always worse than simple systems, and simple systems are bad enough!"

. . .WA4UZM

"I wouldn't mind so much—but she got custody of our color TV and my short wave rig."

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December 1968

ISSUED SEPT. 1

J. H. Nelson

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	14	14	7	7	7	7	7	7	14	21	21A	21
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INDIA	7A	7A	7B	7B	7B	7B	7B	14	14B	7B	7B	7
JAPAN	21	14	7B	7B	7	7	7	7	7	7B	14	21
MEXICO	14	14	7	7	7	7	7	14	21A	21A	21	21
PHILIPPINES	21A	14	7B	7B	7B	7B	7	7	14	14	7B	14A
PUERTO RICO	21	14	7	7	7	7	14	21A	28	28	28	21A
SOUTH AFRICA	14	14	7	7B	7B	7B	14	21A	28	28	21A	21
U. S. S. R.	7	7	7	7	7	7	7B	14	14	14	7B	7B

WESTERN UNITED STATES TO:

ALASKA	21	14	7	7	7	7	7	3A	14	21	21	21A
ARGENTINA	21	14	14	7	7	7	7B	14A	21A	28	28	21
AUSTRALIA	28	28	21	14	14	7	7	7	14	14A	21	21
CANAL ZONE	21	14	14	7	7	7	7	14A	21A	28	28	28
ENGLAND	7B	7	7	7	7	7B	7B	7B	14A	21	14	7B
HAWAII	28	28	21	14	14	7	7	7	14	21A	28	28
INDIA	14	14A	7B	7B	7B	7B	7B	7	14B	7B	7B	7B
JAPAN	28	21A	14	7B	7	7	7	7	7	7B	14	21A
MEXICO	21A	14	7	7	7	7	7	14	21A	28	28	28
PHILIPPINES	21A	21A	14	7B	7B	7	7	7	14	14	7B	14A
PUERTO RICO	21A	14	7	7	7	7	7	14A	21A	28	28	28
SOUTH AFRICA	21B	14	7	7B	7B	7B	7B	14	21A	28	21A	21
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14	14B	7B	7B
EAST COAST	21	14	7A	7	7	7	7	14	21A	28	28	28

A - Next higher frequency may be useful this period
B - Difficult circuit this period

Good: 1-5, 11-14, 16-21, 23, 24, 26-29, 31

Fair: 6, 8-10, 15, 25, 30

Poor: 7, 22

Caveat Emptor?

★ **Price—$2 per 25 words for non-commercial ads; $10 per 25 words for business ventures. No display ads or agency discount. Include your check with order.**

★ **Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.**

★ **Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.**

★ **We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.**

★ **For $1 extra we can maintain a reply box for you.**

★ **We cannot check into each advertiser, so Caveat Emptor . . .**

TELETYPE MOD. 14 reperforator with automatic tape take up rewinder new, unused, $69.95 . . . 4-400's $14.95 . . . transformers: Plate 5KV-1.6ADC $59.95 . . . Modulator 811A's $35 . . . Filament 12.6DCT-10A $4.95. Ideal for transistor supply, battery charger . . . catalog 10¢. Fertik's, 5249A "D", Phila., Pa. 19120.

RF MULTIMETER measures ten millivolts to three volts rms and VSWR down to 1.05:1 as high as 2GHz. RADEVCO, Box 8450, Baltimore, Maryland, 21234.

VIBROPLEX or semiautomatic key wanted. Write Box 691, Savannah, Georgia, 31402.

MERRY XMAS AND HAPPY NEW YEAR from WØCVU. See you at Des Moines, Iowa. June 20-22, ARRL 1969 National Convention.

CHRISTIAN HAM FELLOWSHIP being organized for Christian fellowship and gospel tract work among licensed amateurs. Christian Ham Callbook for $1 donation. For details write Christian Ham Fellowship, 5857 Lakeshore Dr., Holland, Mich. 49423.

WANTED: GONSET #3269, 100KC calibrator, or circuit diagram, used in G-76. Swap: Ranger II and 6 Meter SSB gear for G-76 or Gonset 2 meter gear. J. Gysan, 53 Lothrop St., Beverly, Mass. 01915.

ON AIR NOW: Apache, SB10 SSB, SWR, All Heath, all in like-new condition. $159.50 FOB. Newton, Mass. K1ZYG.

WANTED: McElroy XTR-442-C automatic tape keyer and tape perforator. John R. Hinegardner WØBFB, Mitchelville, Iowa. 50169. Phone 515-967-2898.

NCX-200, USED ONLY FIELD DAY, $300, in original box. Will include heavy home built supply free. FOB. WAØNDV, 611 No. Hartup, McPherson, Kansas 67460.

CRYSTALS—Low frequency types. Available at $2.50 each postpaid USA in hermetically sealed HC-6 or HC-13 metal holders with 2-2½" wire leads. Frequency in kilocycles. 2.000 4.0457 6.400 16.000 32.000 75.000 96.000 100.000 128.000 183.000 218.000. 4-page brochure available for stamp. Quaker Electronics, Hunlock Creek, Pa. 18621.

DISCOUNT PRICES. All equipment listed is new, factory sealed cartons, full manufacturers warranty. Our policy: new equipment at low prices. Swan SW-500C $468, SW-350C $378, Swan 14-117 AC-DC P/S $115, Hygain TH6DXX (Reg. $159) $135, TH3MK3 (Reg. $125) $112, CDR Ham-M rotator with indicator $99.95, Tri-ex W-51 self supporting crank up tower (Reg. $362) $299.95 prepaid, Mosley TA-36 (Reg. $153) $137, TA-33 (Reg. $121) $109, Hammarlund HQ-180A (Reg. $480) $432. Many factories prohibit discount advertising; write or call for discount price catalog on brands not listed in this ad. Time payments available. Bryan Edwards Electronics, 1314-19th St., Lubbock, Texas. 806-762-8759.

WANTED: Magazines, VHRer & ATV. K6KTP, Berry St., Lemon Grove, Calif. 92045.

HQ100 WITH SPEAKER and xtal BFO very good at $110; DX40 oldie but goodie at $40; Knight V44 $15. N. Dowling, 733 Mohawk, Lynchburg, Va. 24502.

HQ-140X, VALIANT I, B&W51SB. Good condition. With manuals. $235.00. Shipping collect. John Rains, 3200 Long Blvd., Nashville, Tenn 37203.

WANTED: Must have manual and/or instruction book for Heathkit DK-40 XMTR, will pay cost. Philip Napora, 474 Tonawanda St., Buffalo, N.Y. 14207

NEGATIVES MADE for use with photoresist P.C. boars. As described in Aug. 73. 4x5 in. $2.00. D. Goodman, Bx 94, Catheys Valley, Calif. 95306.

FOR SALE: Motorola FMTR 80D, 52.525 Mc with AC supply, accessories, no speaker. $95. FOB. C. G. Reinsel W3WUA. Box 25, Bigler, Pa. 16825.

COMMUNICATIONS TECHNICIAN position desired, 16 years experience, first class phone and advanced class amateur. Family, willing to relocate. Write for resume. 73. Box 1168, Peterborough, N.H. 03458.

SELLING MY old radio books, magazines, catalogs, and parts. Send stamped, addressed envelop for price list. W6CID, Elmer A. Piercy, Box 666, Victorville, Calif. 92392.

SWAN 250 6 METER Transceiver with power supply, $250. Vanguard TV camera, $175. Lafayette HA-6, $65. P. Franson WA7KRE, 7312 E. Oak St., Scottsdale, Arizona 85257. 602-947-6052.

NEEDED: Electronic maintenance and operation men for color TV station control room work. First class ticket required. Salary range, depending on experience, $600-$700 a month. Call collect 313-239-6611 or write Chief Engineer, WJRT-TV, Flint, Mich. 48503.

AMATEUR RADIO CERTIFICATE: Display impressive 8½" x 11" personally endorsed certificate in your shack. Send $1.00 to Amateur Radio Certificate, Box 244, Miami (Kendall Br.) Fla. 33156.

WRL'S USED GEAR has trial—terms—guarantee! 900A Sidewinder—$219.95; Galaxy 5—$289.95; Galaxy 300—$159.95; HW22—$89.95; HT40—$49.95; HX500—$289.95; 51J3—$449.00; 75A1—$169.95; NC155—$119.95; NC190—$139.95; SB300—$249.95; RME6900—$149.95; and hundreds more. Free Blue-Book list. Write WRL, Box 919, Council Bluffs, Iowa 51501.

DRAKE 2-A FOR SALE, $100. Want SK-506 chimney and APX-6 in any condition. LA35G1W4, K. Midtseter, 1490 NW 58 Terrace, Ft. Lauderdale, Fla. 33313.

FOR SALE: Yaesu FTDX 400—$325. Heath HR 20—$70. SB 175—$50. With all manuals. WB4APZ, 1900 8th Ave., Immokalee, Fla. 33934. (813-OL7-3288).

NATIONAL 200, AC-200. Absolutely mint condition. In original cartons. $320 or best offer. Terry Taylor, 1459 Jaywood, Creve Coeur, Mo. 63141.

SALE: Comdel Speech Processor (CSP-11) excellent condition, $75 PPD. WB6YVW, 1755 N. Wilcox, Hollywood, Ca. 90028.

THE WHEATON COMMUNITY RADIO AMATEURS (WCRA) will hold the 7th annual Mid-Winter Swap and Shop Sunday, February 16, 1969 at the DuPage Count Fair Grounds, Wheaton, Ill. Hours—9:00 a.m. to 5:00 p.m. $1.00 donation at the door. Refreshments and unlimited parking. Free coffee and doughnuts 9:00-10:00 a.m. Hams, CBers, electronic hobbyists, friends and commercial exhibitors are cordially invited. Contact Bill Lester, WA9FGP, Box 1, Lombard, Ill. 60148 for information.

WANTED: Teletype equipment & parts. Also R-390A, U-R, R-220, etc. Cash or trade for new amateur equipment. All-tronics-Howard Co., Box 19, Boston, Mass. 02101. (Tel. 617-742-0048).

MICRO-MICRO-TO-KEYER: Perfect code from one cubic inch, microcircuit digital electronic keyer module designed for mounting inside any transmitter. Speed range 4-40 WPM. Grid block keying only allows price of $19.95. Includes mounting hardware. Unconditionally guaranteed. Micro-Tech Labs. PO Box 884 (I.A.B.), Miami, Fla. 33148.

ESTATE LIQUIDATION: Telrex combination beams 10M-518 over 15M-525 over 20M-505. Self supporting tower 50 ft. and H.D. rotator cost over $1000. Asking price $200 and you take down. Mint condition. Arthur W. Lee, Rt. #1, Box 23A, North Monmouth, Maine 04265; Tel. 207-933-2869.

ESTATE LIQUIDATION: Collins 75A4 receiver serial 3316 and matching speaker two filters F455-J-08 and F445-J-31; Collins KWS-1 SSB-AM transmitter serial 953. New final tubes, mint condition. $650 for both. Arthur W. Lee, Rt. #1, Box 23A, North Monmouth, Maine 04265; Tel. 207-933-2869.

SELL: COLLINS KWS1-1721 $795, 75A4-4325 $450, both $1150, prefer local sale, like new, ship cod original packing. Barnett, 1310 Navajo, Florissant, Mo. 63033.

"NORTHERN CALIFORNIA HAMS." Best deals—new and reconditioned equipment. Write, call or stop for free estimate. The Wireless Shop, 1305 Tennessee, Vallejo, Calif. 707-643-2797.

WANTED: Back issues of 73 Magazine, November 1960 through March 1961. C. W. Janes K2KS, 2 Windsor Gate, Upper Saddle River, N.J.